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IPCC TRUST FUND PROGRAMME AND BUDGET

Any other matters

Task Group on Data Support for Climate Change Assessments

(Prepared by the Co-Chairs of the Task Group on Data Support for Climate Change Assessments)

(Submitted by the Secretary of the IPCC)

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IPCC TRUST FUND PROGRAMME AND BUDGET

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Task Group on Data Support for Climate Change Assessments

This document describes the activities undertaken by the Task Group on Data Support for Climate Change Assessments (TG-Data) since the last update presented during the Sixty-first Session of the IPCC in July 2024. It also presents a detailed Work Plan for DDC activities in 2025 for the Panel's consideration, as a prerequisite for approving the 2025 budget.

1. Salient activities since last report

1.1. Meetings

- TG-Data Face to Face meeting held in Singapore, October 20-24, 2024.
- 15th TG-Data teleconference held 2024-08-28
- 16th TG-Data teleconference held 2025-01-06
- Monthly IPCC Data Distribution Center (DDC) managers meetings

1.2. Outreach

- Alaa Al Khourdajie (WGIII AR6 TSU) and David Huard delivered an invited webinar, *Artificial Intelligence in the IPCC Process*, to the SIGIR 2024 workshop in the session MANILA24: Information Retrieval for Climate Impact, July 18, 2024.
- David Huard presented TG-Data activities at the Centre for Climate Research Singapore on October 24, 2024, during the TG-Data annual meeting.
- David Huard delivered an invited webinar, *Metadata Pipelines in IPCC Assessment Reports* at the Climate and Forecast Convention Workshop, September 17, 2024.
- José Manuel Gutiérrez delivered a presentation, *Provenance for (complex) climate products: The experience from the IPCC Interactive Atlas* at the Climate and Forecast Convention Workshop, September 17, 2024.

See additional outreach activities carried out by DDC members in the DDC report (Appendix A).

1.3. DDC Funding

Following P-61, the Secretariat has worked with WMO's procurement, partnerships and legal offices to identify the most feasible and practical options / means to transferring the IPCC Trust Fund resources to DDC partners. The options considered included tendering through a call for bidders to contribute to DDC services, combining both in-kind and paid contributions and partnership agreements with existing partners. After careful evaluation and consultations with respective offices, it was determined that the procurement route is incompatible with WMO procurement rules. Consequently, WMO has proposed to sign partnership agreements with current DDC members for 2025, similar to arrangements made in 2024, assuming their continued interest in providing services to DDC.

The Secretariat has contacted the current DDC members to solicit their interest to continue collaborating with DDC. CIESIN, MetaDataWorks and CEDA have responded favorably to a call for expression of interests from the IPCC Secretariat. Under cost-sharing agreements, CIESIN would be willing to undertake, among other tasks, data curation for the SRCities report, while MetaDataWorks would maintain and develop the DDC Catalog and help desk, design metadata workflows and training material, while CEDA would assist with the curation of WGI data, author training and archival of complex citations.CSIC will continue hosting the AR6 WGI Interactive Atlas. DKRZ, a DDC member since the creation of DDC, has announced its decision to progressively pull out of the DDC While this does not jeopardize the accessibility of datasets held at DKRZ,it does raise the question of who will

be responsible to collect, prepare and store the large volumes of model outputs used in AR7 and link them to final data products. As a reference, DKRZ stored approximately 170Tb of data for AR6 and 2Pb since 1997.

A description of DDC 2024-2025 activities is provided in Appendix A. 2024 IPCC funding was made available in June 2024 to MetaDataWorks and July to CIESIN. Detailed reports of funded activities will be delivered at the end of each organisation's funding period. A summary 2024-2025 DDC workplan status presented at P60 is shown in Section 2. The 2025-2026 work plan and budget submitted by DDC members is included in Section 3.

Recognizing the need to sustain the DDC operations and costs of DDC services and their long-term impact on IPCC finances, the Secretariat plans to publish a "Call for resource mobilization" to invite countries to contribute to DDC services. The hope is that this new measure will help retain current DDC members, and attract new institutions willing to contribute their expertise and resources to the DDC, and ultimately improve data access for authors and stakeholders everywhere. TG-Data encourages government delegates and observer organizations to approach institutions with expertise in scientific data management and long-term archival, gauge their interests in participating in IPCC activities as DDC members, and respond to the call for resource mobilization.

1.4. DDC Catalog

Close to 25,000 users visited the DDC Catalog web page in 2024 (Jan 1 to Dec 31). Of those, 461 performed 1,673 catalog search queries, leading to a total of 4,006 direct downloads from MetaDataWorks' archives. Because WGI datasets are stored at CEDA and CIESIN, they do not appear in the MetaDataWorks download statistics, but CEDA recorded around 35,000 downloads from its AR6 holdings; see Section 6 of Appendix A for details. The five most viewed dataset pages are shown in Table 1. The MetaDataWorks service desk received 111 tickets in 2024, 89 of which have been resolved.

Table 1 Five most viewed dataset pages in 2024.

Dataset title	**Views**
Global surface temperature changes in °C relative to 1850–1900	3,956
A comprehensive and synthetic dataset for global, regional and national greenhouse gas emissions by sector 1970-2018 with an extension to 2019	3,741
Technical Summary of the Working Group I Contribution to the IPCC Sixth Assessment Report - data for Figure TS.15	2,360
20 and 30 year climatologies from CMIP3 climate model output as used in the 2007 IPCC Fourth Assessment Report (AR4)	1,334
IPCC AR5 Seasonal temperature and precipitation extremes in IPCC regions for CMIP5	1,172

1.5. Data Curation

As of January 2025, the DDC Catalog holds 346 final datasets underlying IPCC AR6 figures, and close to 2,500 input data collections. Since the last report, most of the new entries in the DDC catalog stem from the effort led by CIESIN to archive Synthesis Report (SYR) datasets. Table 2 shows the current status of the DDC Catalog, and more details about the data rescue effort for SYN can be found in the DDC Annual Report (Appendix A).

Table 2 Number of AR6 datasets currently indexed in the DDC Catalog, and from those, the number of datasets added to the catalog in 2024.

Group	Datasets	2024 additions
WG I	226	+125
WG II	41	+1
WG III	39	
Synthesis Report	40	+24
AR6 Input Datasets	2,468	+741 (DKRZ) + 2 (Interactive Atlas)
Total	2814	+934

2. 2024-2025 DDC work plan status

Table 3 Update on status of DDC work plan for March 2024-March 2025, presented at P60. Note that the contracts signed by each institution with WMO include slight changes from the original work plan.

Tasks (March 2024 - March 2025)	**Progress**	**Lead**
Maintain the DDC Catalog until March 2025	Up and running. See Appendix A Section 5	MDW
Ingest remaining AR6 datasets prepared by AR6 TSUs	Ingested 934 data sets to DDC catalog (see Appendix A Section 4) Ongoing with data rescue effort	
Update to DDC Catalog web pages	Updated web pages Ongoing with data rescue effort and other needs, e.g., error corrections	
Operate Catalog help desk until March 2025	Reported 2024 DDC catalog help desk (see Appendix A Section 6)	
Regional CMIP6 data subset archival in support of developing countries	Depends on fate of LoA with DKRZ	DKRZ
Publish the DDC CMIP6 input data subset archive in and make the data accessible through the Earth System Grid Federation (ESGF),(similar to the CMIP5 data snapshot)	Depends on fate of LoA with DKRZ	
AR6 Adaptation Feasibility Database retrieval and archival (a collection of ten individual data sets)	Completed evaluation/assessment on the individual data sets) with a formal TSU officer. Archival could not be completed because the relevant AR6 data authors were all unresponsive.	CIESIN
AR6 Scenarios Database (1.0, 1.1) archival	Completed data retrieval and evaluation. Ongoing, both versions can only be dark archived due to data licensing agreement.	
AR6 WGII Input data sets retrieval and archival:		

1. Supplementary materials and annexes from the International Water Management Institute for WGII Chapter 4	Completed evaluation with a formal TSU officer. Ongoing, pending on response and cooperation from AR6 data authors.	
2. WorldRiskIndex (WRI) data from University of Stuttgart for WGII Chapter 8	Completed evaluation with a formal TSU officer. Ongoing, pending on response and cooperation from AR6 data authors.	
Update to the DDC catalog records for AR6 WGI data sets	Task item removed on the final LOA signed by CEDA and WMO.	CEDA
AR6-CMIP6 provenance connection.	Task item removed on the final LOA signed by CEDA and WMO.	CEDA
AR6 data status and gap report (WGI, WGII, WGIII, SYR)	Partially completed for the FAIR paper Ongoing	All DDC Centers
FAIR Guidelines training material	Pending	
Update to IPCC data curation workflow	Updated the workflow with TSU staff and TG-Data members in Singapore F2F meeting. Ongoing	
Update to IPCC metadata schema	Held a DDC-TSU joint meeting on updating the metadata schema Ongoing	
Metadata forms and templates for authors	Discussed in Singapore F2F meeting and monthly DDC meetings. Ongoing	
Annual budget reports on use of the DDC fund	To be completed by June 2025.	
DDC-TSU Training workshop (travel costs to DDC managers)	In the Singapore F2F meeting, DDC prepared training materials with TSUs staff and TG-Data members Ongoing.	All DDC Centers
Outreach activities (travel costs to DDC managers)	Completed multiple outreach activities (see Appendix A Section 3) Ongoing.	

3. TG-Data AR7 work plan

Table 4 TG-Data work plan from 2024 until the beginning of the AR8 cycle.

Activities	Sub-activities	Start date	End date	Deliverables
Administrative	Preparation of the TG-Data document for IPCC/Bureau meetings	2024-01	2030-05 Tuned to WG cycle IPCC and Bureau meetings	Updated report on activities
	Refine work plan to present at BUR68 and P61	2024-09	2024-10	New TG Data workplan
	Update TG Data membership	2025-05	Author nomination	New TG Data membership
	Refining the draft work plan after new TG Data composition	2025-07	2025-12	Finished workplan
Author support	Review FAIR guidelines	2024-08	2025-03	Updated FAIR guidelines, reviewed by TG-Data, endorsed by bureau and published
	Organise introductory sessions at LAM1 SR Cities and AR7 (all WGs)	2025-01	2025-12	Sessions at LAM
	Organise training workshops at LAM2 (SR Cities and AR7) for authors and chapter scientists on DDC services and FAIR guidelines	2025-07	2026-06	Training workshop at LAM
	Organise virtual training workshops during FOD review process	2025-10	2026-09	Training workshops (different time zones)
DDC Oversight	Discuss DDC annual report and provide recommendations	Every year		Recommendations to DDC
	New DDC Structure for AR7. Includes preparation of open call for DDC participation, Q/A sessions, selection of bids, integration of new DDC members	2024-03	2025-05	DDC for AR7 in operation - Updated MOU
DDC Support	Maintain DDC Catalog	2024-04	2025-03	DDC Catalog
	AR6 data status and gap report	2024-03	2024-12	Data status and gap report
	DDC - TSU (all WGs) Training on DDC services and FAIR guidelines	2024-10	2025-03	Training workshops

	Engagement (DDC liaison) with input data providers (e.g. IIASA or CMIP). Includes signing MoUs by Co-Chairs with data providers to clarify licensing conditions.	2024-10	2026-12	Minutes / MoUs
	Update and harmonise IPCC data curation workflow and metadata schema for long-term preservation of datasets.	2024-10	2025-06	Updated workflow
	Development of tools for authors (e.g. provenance tracking tools, automated metadata compliance checks)	2024-04	2025-12	New tools
	In collaboration with WG TSU, identify datasets to be curated and relay to DDCs	2026-01	2028-05 Tuned to WG cycle	Live queue of datasets to be archived by DDC
	Liaise between IPCC TSUs and DDC to assist authors and harmonise metadata requests across WGs and DDC Partners	2026-01	2029-05 Tuned to WG cycle	Improved efficiency in data curation
	DDC outreach activities	2024-11	Tuned to WG cycle	AGU/EGU/International Data Week/UN WDF, etc. demos/presentations/workshops
Outreach	Prepare proposals for establishment of partnerships for outreach activities	2026-01	Tuned to WG cycle	MoU with external organisations
	Prepare proposals for expert meetings	2024-03	2024-08	Expert meeting proposal
	Organise outreach activities from IPCC AR7 products	2026-01	2029-12 Tuned to WG cycle	Training workshops
TG Data Activities	Collaboration between WGs-DDC-TG Data in FAIR data processes	2024-03	2025-06	Minutes
	F2F	Every year until 2030		Report
	TelCon	2-3 per year until 2030		Minutes

4. DDC 2025-2026 work plan and budget

Table 5 DDC 2025-2026 work plan and budget.

DDC Centers	Tasks and Deliverables	In-kind contributions	Cost breakdown (CHF)	Cost to IPCC (CHF)
MDW	1. Maintain the DDC Catalog until June 2026 2. Update to DDC Catalog web pages when necessary 3. Operate the Catalog help desk until June 2026. Deliverables: reports of user statistics and distributions, issues, etc, to the DDC Managers' monthly meetings, and to quarterly/annual consolidated reports to TG-Data	0.5 FTE ~64,236 CHF	64,236	**77,136**
	4. Contribute to FAIR and other guideline training materials. Deliverable: contribution to two consolidated reports with other DDC centers. 5. Participate in DDC-TSU Training workshop or/and outreach activity (EGU/AGU/UNWDF/Int'l Data Week) (travel costs depending on the location/time of the activities). Deliverable: contribution to a consolidated report of the workshop and/or the activity with other DDC centers.		12,900	
DKRZ	1. Serve as TG-Data liaison in WGCM Infrastructure Panel (see WIP's ToR: https://doi.org/10.5281/zenodo.13951132) until replaced by DDC Partner for CMIP7 data Note: DDC Management and Operations, including preservation of historical data, are covered by DKRZ's in-kind contribution of 0.5 FTE (70000 CHF).	0.5 FTE ~ 70,000 CHF	0	**25,900**
	2. Contribute to Complex Citation and provenance implementation into AR7 based on AR6 pilot implementation.		5,000	
	2. Participate in the TG-Data and DDC meetings Deliverables: contribute to TG-Data progress reports, annual DDC Report 3. Contribute to metadata schema update and workflow consolidation with TSU and DDC Partners Deliverable: contribution to consolidated data workflow document with metadata schema 4. Participate in DDC-TSU Training workshop including workshop preparation, participate in outreach activity (EGU/AGU/UNWDF/Int'l Data Week) (travel costs depending on the location/time of the activities). Deliverable: contribution to a consolidated report of the DDC-TSU workshop and further outreach activities.		20,900	

CIESIN	1. Lead DDC data curation support for Special Report on Climate Change and Cities (SRCities) 1.1 Work with TSUs, chapter scientists (if any) and SRCities authors, (and participate in LAM1 and LAM2 if needed), to provide data curation support on data workflow. 1.2 Contribute to extension and harmonization of standardized provenance / citation information. 1.3 Support retrieval of input data and track provenance. In case of issues, help authors to address data licensing and data citation. 1.4 Help preserve and perform version control of the intermediate data generated in the FOD and SOD. 1.5 Help complete other required metadata information, such as temporal and spatial coverages, data formats, required SW/HW, etc. 1.6 Coordinate IPCC FAIR requirements with UCCRN and relevant groups. 1.7 Serve as the liaison with UCCRN and relevant groups on curation of input data and interactive products, e.g., Case Study Atlas (CSA) data, localized city-level geospatial data and maps, high-resolution EO/remote sensing data. Deliverable: Report of SRCities initial data archive at IPCC DDC. 2. Lead DDC data curation support for AR7 WGII 2.1 Work with WGII TSU to enhance the traceability of results and its application as part of the TG-Data data FAIR recommendations, and help integrate WGII author tool support into AR7 data workflow. 2.2 Work with WGII TSU and contribute to WGII-specific data curation training materials and activities. 2.3 Prioritize and support curation of input data sets, contingent on available resource. Deliverable: Report of WGII initial data archive at IPCC DDC 3. Lead DDC data curation support for AR7 WGIII 3.1 Work with WGIII TSU to enhance the traceability of results and its application as part of the TG-Data recommendations, and help integrate WGII author tool support into AR7 data workflow. 3.2 Work with WGIII TSU and contribute to WGIII specific data curation training materials and activities. 3.3 Prioritize and support curation of input data sets, contingent on available resource. Deliverable: Report of WGIII initial data archive at IPCC DDC Note: On 4 December 2024, CIESIN at Columbia University Climate School and NASA SEDAC formally responded to the call for institutional participation of the AR7 data work from the official letter of IPCC Secretary, and confirmed the in-kind contribution in the AR7 cycle: 1 FTE covering maintenance and operations of the CIESIN DDC archive and basic IT & system support for the AR7 cycle. CIESIN DDC also expected cost sharing.	1 FTE ~165,000 CHF + basic IT and system support + 2 graduate student interns	99,500	**120,400**

	4. Host or Participate in the TG-Data and DDC meetings Deliverable: DDC monthly meeting records, contribute to TG-Data annual F2F meetings, telecons. 5. Contribute to data workflow and metadata schema and/or other technical documents across WGs, with TG-Data and DDC partners Deliverable: a consolidated data workflow document with metadata forms and/or other technical documents. 6. Participate in or Coordinate DDC-TSU data curation training workshop including workshop preparation, participate in or coordinate outreach activity (EGU/AGU/UNWDF/Int'l Data Week) (travel costs depending on the location/time of the activities). Deliverable: report of the workshop and/or the outreach activity with other DDC centers.		20,900	
CEDA	1. Update Respond to requirements of SR Cities for data management. Deliverable: report on work done to support SR Cities 2 Participate in or Coordinate DDC-TSU data curation training workshop including workshop preparation Deliverable: contribution to a consolidated report of the DDC-TSU workshop 3. Participate in or Coordinate outreach activity (EGU/AGU/UNWDF/Int'l Data Week) (travel costs depending on the location/time of the activities). Deliverable: contribution to a consolidated report of the outreach activity with other DDC centers. 4. Host or Participate in the TG-Data and DDC meetings Deliverables: contribute to TG-Data progress reports, contribute to annual DDC Report.		5,000 10,000 5,000 5,900	**25,900**

CSIC	1. Hosting and maintenance of existing interactive products (the IPCC WGI AR6 Interactive Atlas and helpdesk) Deliverable: Report including key statistics Note: DDC management and operations incl. hosting and maintenance of existing interactive products are covered by CSIC's in-kind contribution equivalent to 0.5 FTE (40,000).	0.5 FTE ~40,000 CHF		**20,900**
	3. Host or Participate in the TG-Data and DDC meetings Deliverable: DDC monthly meeting records, contribute to TG-Data annual F2F meetings, telecons. 4. Contribute to data workflow and metadata schema, with TG-Data and DDC partners Deliverable: a consolidated data workflow document with metadata schema. 5. Participate in TG-Data, DDC,TSU training workshop or/and outreach activity (EGU/AGU/UNWDF/Int'l Data Week) (travel costs depending on the location/time of the activities). Deliverable: contribute to the report of the workshop and/or the activity with other DDC centers.		20,900	
	Grand Total	2 FTEs, 269,236 CHF		**270,236**

5. Renewal of TG Data membership: Transition Document

According to the TG-Data Terms of Reference (ToR), membership terms on TG-Data align with the IPCC's assessment cycle and must be refreshed at the latest with the comprehensive assessment's author selection process. Since the author selection process is expected to occur a few months after IPCC's 62nd Session (P-62), we anticipate the new TG-Data membership to be in function around June 2025. To ensure a smooth transition, TG-Data has prepared a transition document (Appendix B). This document complements the TG-Data AR7 Recommendations, submitted at the 65th IPCC Bureau Session as Appendix 1 of Document BUR-LX/INF.2. The transition document outlines TG-Data's accomplishments, ongoing work to be completed, and provides recommendations for incoming members for future work, aligned with the roles and responsibilities defined in the TG-Data ToR.

6. Expected outcomes

1. Take note of the activities performed by DDC over the 2024-2025 period.
2. Consideration and approval of the AR7 TG-Data work plan for 2025, contingent upon the approval of the budget for DDC activities for the year 2025.
3. Take note of the recommendations for the next TG-Data Co-Chairs and members based on the AR6 experience.

APPENDIX A – DDC 2024 Report

This report presents the DDC activities associated with both IPCC DDC Fund and in-kind contributions in 2024.

The Letter of Agreement (LOA) between MetadataWorks and WMO was signed April 18, 2024, but 64,900 CHF was made usable on June 4, 2024. The LOA between Columbia University and WMO was signed on May 10, 2024, but 62,900 CHF was made usable to the CIESIN DDC on July 1, 2024. The CEDA letter of agreement was signed by both parties in December 2024. The work will be back-dated from October 2024 and continue to March 2025. CEDA has not yet received funds. DKRZ had not signed the LOA with WMO as of 13 January.

- DDC managers attended TG-Data F2F meeting in Singapore
- DDC managers attended TG-Data quarterly teleconferences
- DDC managers F2F meeting in Singapore (before the formal TG-Data F2F).
- DDC managers F2F during the AGU in Washington DC
- Monthly meetings on DDC operations (on the second Wednesday of every months)
- Five other DDC managers teleconference on special topics, such as funding discussions, metadata schema, etc.

EGU 2024

- Poster: A pragmatic approach to complex citations, closing the provenance gap between IPCC AR6 figures and CMIP6 simulations, C. Pascoe et al. https://doi.org/10.5281/zenodo.10958736
- IPCC FAIR data approach, Open Science and Data Help Desk, M. Stockhause et al., bit.ly/DataHelpEGU24, https://doi.org/10.5281/zenodo.10821975

AGU24 oral sessions and poster sessions

- Using Complex Citations to Close the Provenance Gap Between IPCC AR6 Figures and CMIP6 Simulations, C Pascoe et al. https://doi.org/10.5281/zenodo.14605443
- Implementing FAIR Data Principles in the IPCC AR6 WGI Report, C. Pascoe et al. https://doi.org/10.5281/zenodo.14605539
- Benefit and limitations of the application of the TRUST principles on the jointly managed IPCC Data Distribution Centre, M. Stockhause et al. https://doi.org/10.5281/zenodo.14626702
- Collaborations across boundaries in the Data Distribution Center (DDC) of the Intergovernmental Panel on Climate Change (IPCC) to support climate assessments and interdisciplinary applications, X. Xing et al.
- Building a FAIR Foundation: Managing The IPCC Data Distribution Center (DDC) Catalog, A. Milward et al.

Publications

- Stockhause M, Huard D, Al Khourdajie A, Gutiérrez JM, Kawamiya M, Klutse NAB, et al. (2024) Implementing FAIR data principles in the IPCC seventh assessment cycle: Lessons learned and future prospects. PLOS Clim 3(12): e0000533. https://doi.org/10.1371/journal.pclm.0000533
- Agarwal, D., Ayliffe, J., J. H. Buck, J., Damerow, J., Parton, G., Stall, S., Stockhause, M., & Wyborn, L. (2025). Complex Citation Working Group Recommendation. Zenodo. 10.5281/zenodo.14106602
- Pascoe, C. (2024). Using Complex Citations to Close a Provenance Gap and Open an AI Highway Between IPCC and CMIP. NCAS AI/ML Workshop, University of Reading. Zenodo. https://doi.org/10.5281/zenodo.14276690

A number of additional datasets were added to the DDC Catalog in 2024. The list includes final datasets from WGI, archived at CEDA, DKRZ and CIESIN, but that had not yet been ingested into the DDC Catalog, input datasets, as well as Synthesis Report datasets reconstructed with the help of their authors and former TSU staff.

Table A.1 Current number of datasets indexed in the IPCC DDC Data Catalog, and number of datasets added in 2024

Group	Datasets (2025)	Updates (2024)
WG I	226	+125
WG II	41	+1
WG III	39	
Synthesis Report	40	+24
Historical/AR6 Input Datasets	2,468	+782 (DKRZ) + 2 (Interactive Atlas)
Total	2,814	+934

- The IPCC Data Catalog has been given a new user interface enabling improved search, a data dictionary, a glossary, several new API's to make the catalog machine accessible, new capabilities to add in video and images to data descriptions. These are all features which enhance the "FAIR-ness" of the data, by enabling integration with common data models, and enhancing interoperability and reuse of data.
- 172 Features, improvements or bug fixes have been made to the catalog in the last 9 months, including 13 security updates - MDW monitors NCSC/NIST for new CVE's and takes a proactive stance in fixing new vulnerabilities within 14 days of notification.
- Updates to existing IPCC webpages.

DKRZ data downloads[1]

IPCC DDC users downloaded ca. 112 TBytes and 193 000 datasets in 2024 with mean monthly downloads of 16 000 datasets/month and 9 TBytes/month. Due to the deactivation of the ESGF portal download option end of June 2024, the dataset downloads per month in the second half of 2024 dropped to 3 % of the value for the first half of 2024 (8% of the downloaded volume, see Figure A.1). Because of an increase of downloads of +94 % for datasets and +78 % for volume during the first half of the year compared to the same time period in 2023, the total annual downloads are similar to those in 2023 with 98 % of the dataset download number and 80 % of the download volume of 2023. AR5 data downloads dominate with a share of ca. 90 % of the downloads, 10 % are AR6 data downloads and less than 0.1 % are downloads of SAR, TAR and AR4 datasets.

[1] Stockhause, M. (2025). IPCC DDC at DKRZ: Annual Report 2024 (1.0). Zenodo. https://doi.org/10.5281/zenodo.14609248

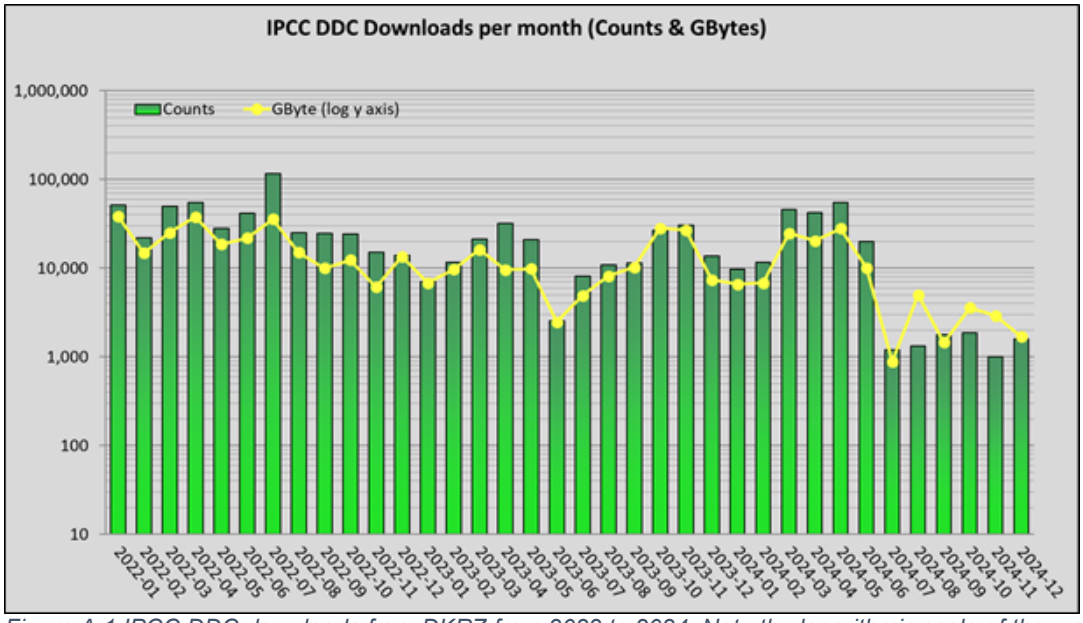


Figure A.1 IPCC DDC downloads from DKRZ from 2022 to 2024. Note the logarithmic scale of the y-axis. Source: M. Stockhause.

The download counts per continent can only be provided for the small portion of data downloaded from the DDC portal, as the regional download information from the ESGF for the first half of 2024 is no longer available. These downloads are dominated by Asian users with 72 %, followed by 11 % downloads from North American and 10 % from Europe, 6 % from Africa and less than 1 % each from South America and Australia (see Figure A.2). Due to the high portion of data downloaded from the ESGF portal, it can be assumed that this share is lower (in 2023 it was about half) and the regional user downloads are more evenly distributed.

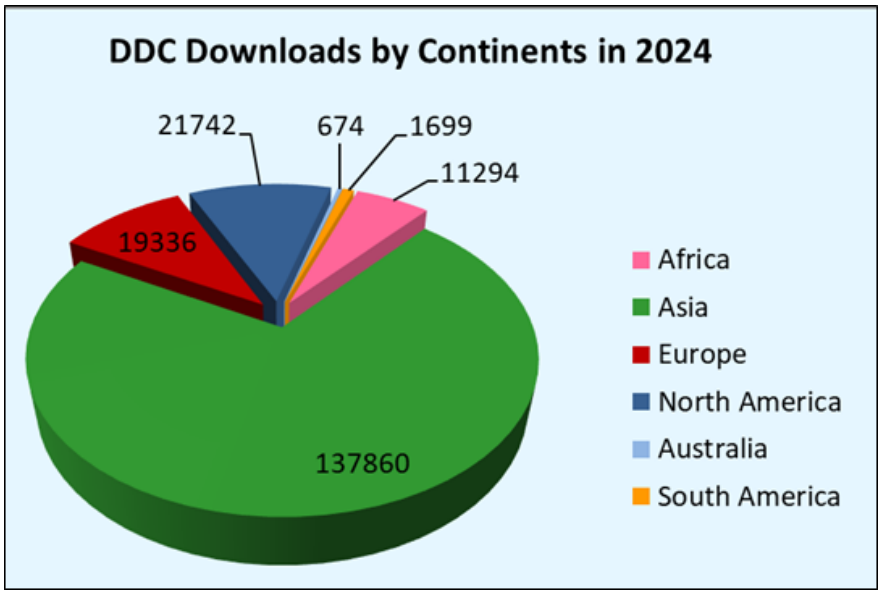


Figure A.2 DDC downloads per continent in 2024 from DKRZ. Source: M. Stockhause

DDC Data Catalog users and downloads

Active Users (1st Jan 2024 - 31st Dec 2024)

Figure A.3 Daily active users (1st Jan 2024 - 31st Dec 2024) visiting the DDC Data Catalog web site. Note that problems with the new Google Analytics GA4 system meant that the analytics were taken offline from 21st January to 4th Feb. 2024, this appears in the graph as if no users were on the system. Source: MetaDataWorks

Active Users by country (1st Jan 2024 - 31st Dec 2024)

Figure A.4 Origin of DDC Data Catalog active users in 2024. Source: MetaDataWorks

Daily Downloads (1st Jan 2024 - 31st Dec 2024)

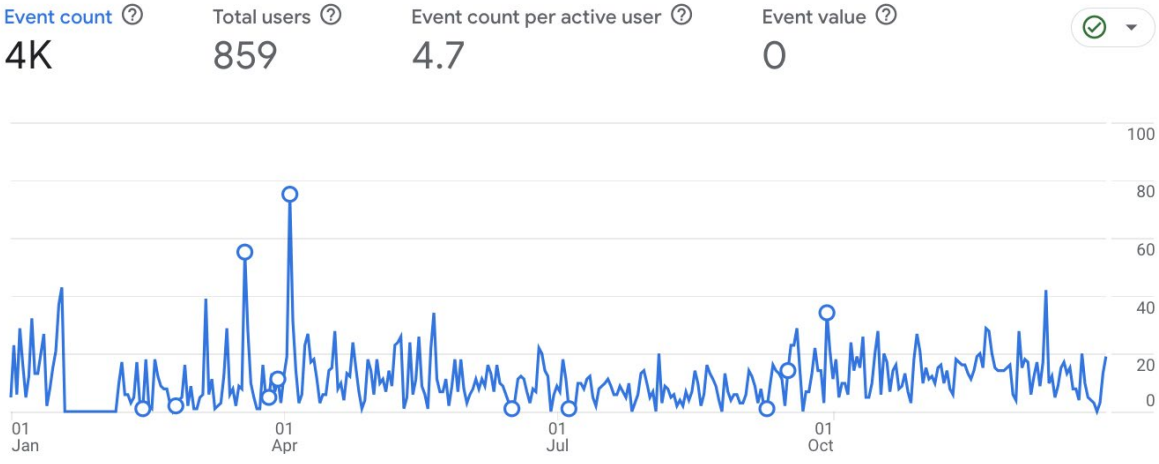


Figure A.5 Number of direct downloads from IPCC DDC Data Catalog. This count does not include downloads from external data providers such as CEDA, DKRZ or CIESIN. Source: MetaDataWorks

Downloads per country (1st Jan 2024 - 31st Dec 2024)

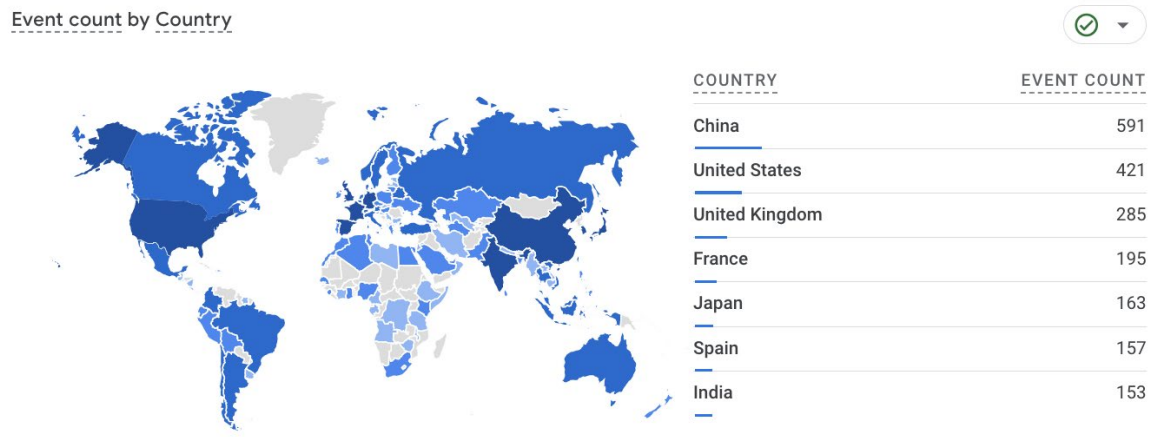


Figure A.6 Origin of DDC Data Catalog downloads in 2024. Source: MetaDataWorks

CEDA

The following figures display download statistics for [IPCC AR6 WGI Figure Data held in the CEDA archive](). The figure downloads recorded here are for the online [OpenDAP]() service which provides users with a clickable interface to download the data.

Downloads by Country

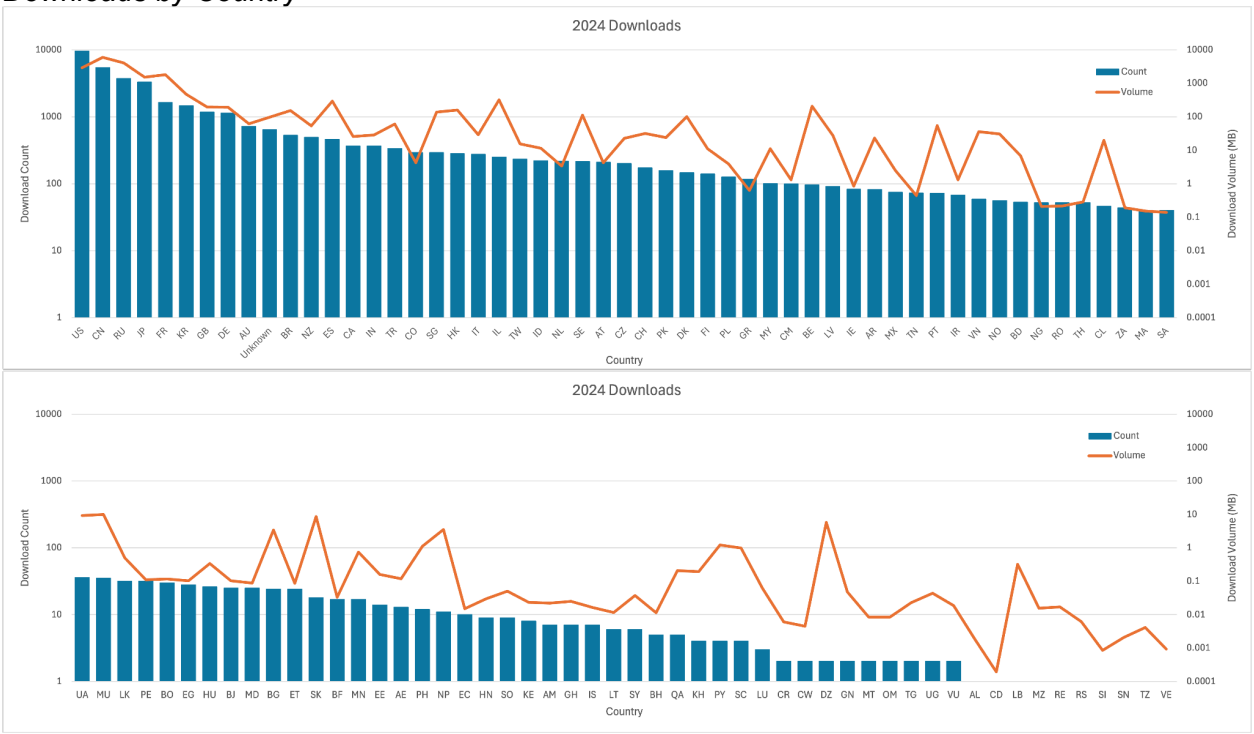


Figure A.7 Annual downloads of figure data by country (Jan 1st - Dec 31st 2024). Note that both the download count and download volume have logarithmic scales for this statistic. The 10 most active countries downloading figure data from CEDA in 2024 were: USA, China, Russia, Japan, France, South Korea, United Kingdom, Germany, Australia and Brazil. Source: CEDA

Monthly Downloads

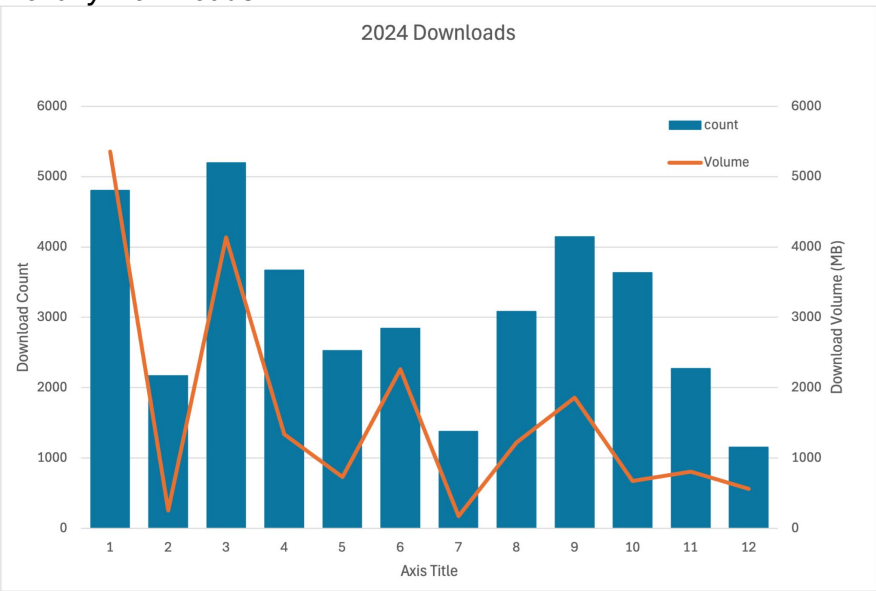


Figure A.8 Number and volume of downloads from CEDA archives in 2024. Source: CEDA

Downloads by Figure

In 2024, by far the most downloaded figure from CEDA was the Summary for PolicyMakers (SPM) Figure A.8, which shows selected indicators of global climate change under the five core scenarios used in the IPCC AR6 WGI report.
https://dx.doi.org/10.5285/98af2184e13e4b91893ab72f301790db

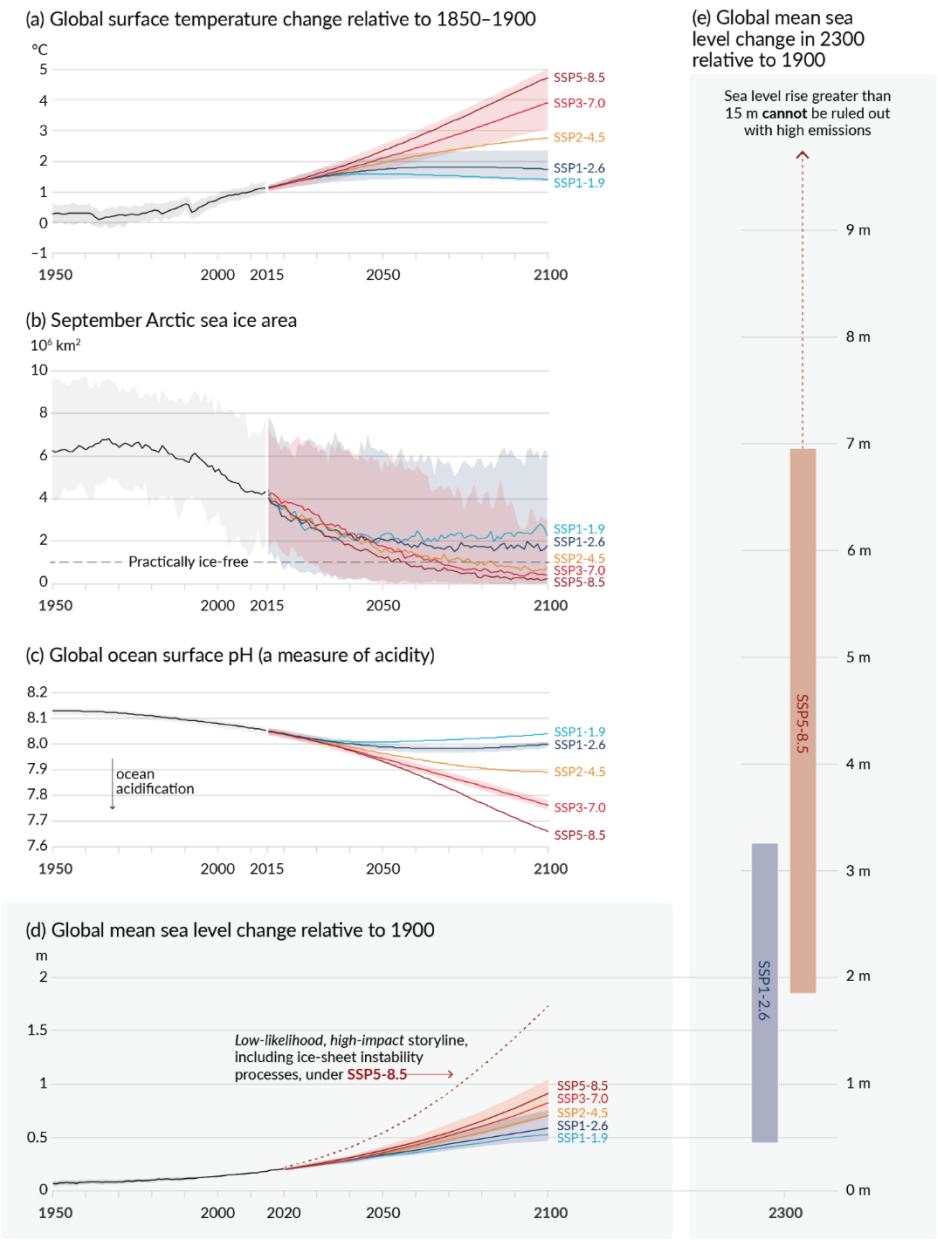


Figure A.9 Figure SPM.8 in IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A.

Figure	Count	Volume (MB)	Figure	Count	Volume (MB)	Figure	Count	Volume (MB)	Figure	Count	Volume (MB)
spm_08	7416	31.59	spm_07	146	0.16	ch3_fig30	67	0.82	ch6_fig23	44	0.17
ch9_fig24	1320	13.27	BOX_ts6_fig1	145	24.09	ch6_fig3	67	0.09	ch12_sm_04	44	0.92
inputdata_TS_12	1169	11.65	ch9_fig06	143	27.38	ch8_fig25	66	14.79	ch4_fig42	43	8.90
spm_01	967	12.41	ch9_fig28	141	48.00	inputdata_ch2_fig16	65	172.99	inputdata_ch7_fig18	43	0.26
inputdata_BOX_ts5_fig1	938	579.92	ch9_fig07	139	57.17	ch3_ccb2_fig1	64	0.14	ch3_fig44	42	0.15
spm_05	931	2293.87	ch6_fig12	133	0.27	ch4_fig31	64	130.95	ch8_fig21	42	6.01
ts_25	756	3.48	ch3_fig21	129	1.48	ch11_fig16	63	6.98	ch9_fig22	42	0.04
inputdata_ch6_fig08	732	6.71	ch6_fig16	124	0.37	ts_19	62	0.10	ch2_fig15	41	0.17
inputdata_ch7_faq3_fig1	709	24.08	BOX_ts4_fig1	123	0.18	ch6_fig6sm3	62	0.22	ch2_fig17	41	0.12
inputdata_ts_24	603	384.02	ch9_ccb9_1_fig1	122	0.42	ch10_ccb4_fig1	60	1.85	ch2_fig38	41	0.08
spm_10	582	2.85	ch9_fig26	118	29.05	ch11_faq1_fig1	60	2.88	ch4_fig19	41	99.28
ts_15	569	1.14	ch2_fig28	115	0.29	ch11_fig03	60	55.76	ch7_fig19	41	0.09
inputdata_ch12_fig10	522	86.84	ch7_fig06	114	7.68	ch2_fig13	59	0.16	ch3_fig39	40	139.25
inputdata_BOX_ts4_fig1	514	6.25	spm_09	114	0.19	inputdata_ch7_fig21	59	1.25	ch4_fig13	40	51.32
inputdata_ch12_fig06	490	130.02	ch3_fig16	111	0.65	ch3_fig26	57	0.49	ch10_fig12	40	0.44
inputdata_ch7_fig13	464	23.13	BOX_ts13_fig1	110	0.97	ch3_fig28	56	4.20	ch2_fig26	39	0.11
CSB_TS1_fig1	426	221.43	ch3_fig25	110	3.71	ch12_sm_06	56	0.38	ch3_fig20	39	0.07
ch3_fig02	412	6.35	ch9_fig09	110	7.08	ch6_fig17	54	0.17	ch7_fig17	39	0.13
spm_04	412	1.08	ch11_fig11	109	14.11	inputdata_ch7_fig03	54	0.72	ch9_fig15	39	19.64
ch9_fig03	408	95.26	ch3_fig41	102	819.82	ch3_faq2_fig1	53	1.10	ch2_fig14	38	0.07
ch9_fig22	406	18.60	ch3_fig04	98	1.84	ch3_fig08	53	0.13	ch3_fig36	38	2.74
inputdata_ch12_fig05	400	93.93	inputdata_ch3_fig28	96	1578.96	ch4_fig12	53	114.25	ch11_fig11_A_1	38	19.85
inputdata_ch6_fig07	370	352.90	ch8_fig13	96	3.06	ch9_fig32	53	2.45	ch2_fig22	37	0.08
ts_01	344	51.75	ch5_fig33	95	0.12	inputdata_ch2_fig23	52	0.23	inputdata_ch2_fig13	37	396.72
ch7_SM_1	335	87.73	ch2_fig05	93	9.26	ch3_fig38	52	17.04	ch3_fig22	37	0.08
inputdata_ch12_fig08	320	67.09	ch2_ccb2_3_1	92	1.47	ch3_fig40	51	197.27	ch4_fig23	37	54.12
inputdata_ch6_fig12	300	716.19	ch8_fig15	92	18.00	ch4_fig32	51	129.53	ch2_fig06	35	0.21
inputdata_ch6_fig22	297	21.04	ch10_fig06	90	3.16	ch6_fig6sm5	51	1.48	ch3_faq3_fig1	35	0.75
ch2_fig04	292	15.49	ch3_fig09	87	924.73	ch2_fig09	50	0.11	ch3_fig11	35	0.16
spm_06	291	0.71	ch6_fig22	86	1.35	inputdata_ch2_fig15	50	1158.20	ch7_fig11	35	0.07
inputdata_ch12_fig09	257	39.22	ch10_fig11	84	2.02	ch3_fig33	50	510.86	ch3_fig24	34	0.47
ch12_fig04	248	254.40	ts_fig17	82	0.25	ch4_fig41	50	22.97	ch3_fig27	34	3.07
spm_02	248	0.40	BOX_ts2_fig1	81	0.08	ch8_fig14	50	8.17	ch4_fig24	34	47.19
ch9_fig14	233	713.25	inputdata_ch7_BOX2_fig1	81	1.45	ch8_box8_2_fig1	49	9.07	inputdata_ch7_fig04	34	0.21
ch10_fig10	233	11.95	ch8_fig17	81	17.19	ch3_fig06	48	2.37	inputdata_ch2_fig27	32	209.99
inputdata_ch12_fig07	228	44.02	ch10_fig18	80	0.58	ch6_fig21	48	0.42	inputdata_ch2_fig25	31	0.10
inputdata_ccb9_fig1	210	3.47	ch10_fig13	79	3.77	ch12_sm_03	48	1.08	ch3_fig17	31	8.85
ch9_fig12	189	149.27	ch9_fig13	78	32.81	ch4_fig26	47	27.60	ch3_fig32	31	0.21
ch9_fig30	187	1.90	ch3_faq1_fig1	77	1.02	ch8_fig26	47	0.43	ch12_sm_02	31	0.67
ch3_ccb1_fig1	186	3.11	BOX_ts2_fig2	76	0.08	ch9_fig05	47	36.21	inputdata_ch7_fig05	30	0.04
inputdata_ch2_fig11	182	2.76	ch12_sm_01	76	2.02	ch9_fig11	47	17.73	ch7_faq3_fig8	30	0.17
ch2_fig11	172	1.71	ch6_fig20	74	2.88	ch9_fig29	47	0.06	ch7_faq3_fig7	28	0.75
ts_09	171	8.21	inputdata_ch2_fig29	72	0.09	ch12_sm_05	47	0.98	ch7_faq3_fig6	28	0.05
ch10_fig19	170	8.00	ch10_fig20	72	1.54	BOX_ts7_fig1	46	0.10	ch7_faq3_fig5	27	179.66
ch10_fig21	169	253.97	inputdata_ch6_fig14	71	4705.02	ch3_fig31	46	0.62	ch7_faq3_fig4	27	2.17
inputdata_ch2_fig12	168	4.80	ch9_fig04	71	31.71	ch4_fig22	46	35.75	ch7_faq3_fig3	25	30.53
spm_03	156	0.44	ch6_fig24	70	0.11	ch3_fig07	45	0.11	ch7_faq3_fig2	24	0.28
ts_22	155	3.15	ch8_fig18	69	15.12	ch6_fig25	45	0.10	ch7_faq3_fig1	23	0.17
ch2_ccb2_1_1	154	72.92	ch2_fig12	67	0.42	ch6_fig6sm4	45	0.32	ch7_faq3_fig0	23	0.28
ch11_fig19	147	21.81	inputdata_ch2_fig02	67	19.88	ch2_fig25	44	0.06	ch7_faq3_fig1	18	0.03

Figure A.10 2024 annual download counts and download volumes for the IPCC AR6 WGI figure data at CEDA. spm: Summary for policy makers, ts: Technical summary, ch: Chapter, fig: Figure

Service Desk

Figure A.11 shows the number of DDC Catalog service desk tickets created and resolved each month in 2024.

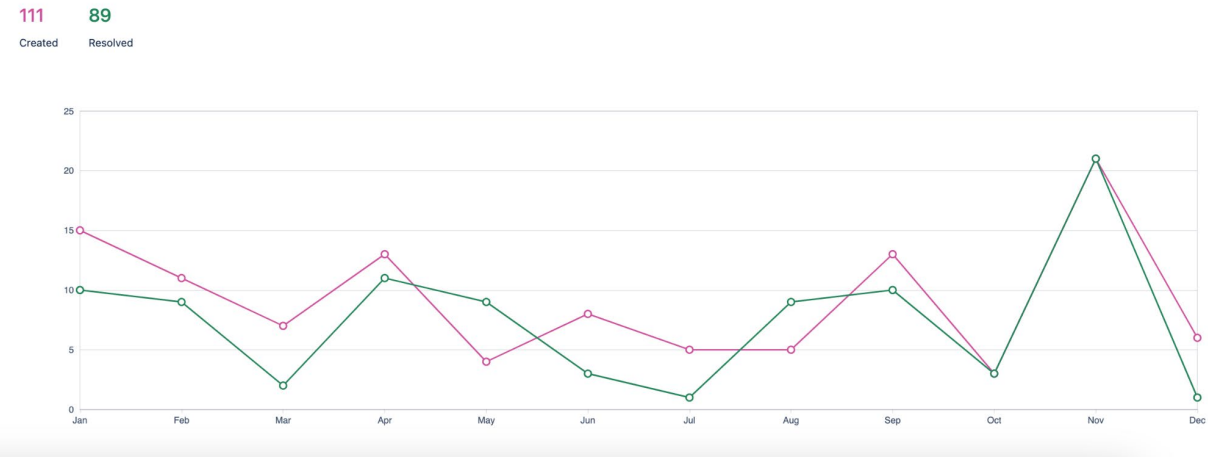


Figure A.11 Number of service desk tickets created and resolved by month. Source: MetaDataWorks

AR6 data rescue at CIESIN DDC

The data rescue work was supported by NASA SEDAC funding and IPCC DDC Fund.

After AR6 TSUs were closed, requests for access to IPCC data sets nevertheless continued, especially for those of WGII, III, and Synthesis Report (SYR). Many of the data sets were not archived, and some were missing or lost. The DDC was advised by the AR6 TSU officers to work directly with authors to track and retrieve the data. With voluntary help from former TSU officers, chapter scientists and authors, the DDC completed a preliminary evaluation of AR6 final data curation. Due to resource constraints, the decision was to focus on the critical data rescue for the SYR, which was widely used and cited, such as by NASA's new decadal Earth Science to Action Strategies 2024-2034 (NASA ES2A).

DDC worked with TG-Data and AR7 TSU data officers who served as the ex-officio members to establish the procedure of archiving and dissemination of the rescued data sets, as well as the formal review and approval for publication. The procedure was approved at a TG-Data teleconference. DDC compared every data piece with the published SYR figure panels, and resolved some discrepancies and technical issues with authors. DDC evaluated the data licensing requirements of all the data sets retrieved. Table A.2 describes the number of datasets retrieved from SYR and their current processing status. Table A.3 lists the datasets rescued or being processed, including links to final datasets at CIESIN and within the DDC Catalog.

Table A.2 Status of datasets evaluated and processed through the data rescue effort.

SYR Data sets retrieved	52
SYR data sets with technical issues resolved	41
SYR data sets with licensing issues resolved	38
SYR data sets reviewed and approved by TG-Data, and published by DDC by 31 December, 2024	22
SYR data sets reviewed and approved by TG-Data, pending publication	5
SYR data sets pending review and approval	11
SYR data sets in the queue to be processed with licensing and technical challenges	14

Some of the data sets may never meet the requirements for publication. In those cases, it was suggested and agreed by the formal TSU officers that the DDC could dark archive them (store them without making them public). The challenges include missing or lost data after the closure of the TSUs, missing data licensing agreements, version control issues, and missing quality assurance/quality control (QA/QC) so that some data did not match the published figures. We note that it costs much more time and effort to track, retrieve, archive, and resolve the legal and technical issues *a posteriori*. If DDC and TSUs work closely together from the very beginning, similar issues can be avoided in AR7.

Table A.3 List of rescued datasets published, with assigned DOI and Catalog link, followed by datasets being processed.

WGs	SYR Figure	Panel	Title	DOI	DDC Catalog Link
I, II & III	LR Cross-Section Box.2, Figure 1	Panel (a)	Schematic of the AR6 framework for assessing future greenhouse gas emissions, climate change, risks, impacts, and mitigation	10.7927/baxv-nj53	Link

WGs	SYR Figure	Panel	Title	DOI	DDC Catalog Link
III	LR 4.1	Panel (a)	Sectoral emissions in pathways that limit warming to 1.5°C	10.7927/42f9-9t48	Link
II	SPM 4 and LR 3.3	Panel (c) (right)	Risks to coastal geographies increase with sea level rise and depend on responses	10.7927/khbw-9920	Link
I & II	LR 3.4	Panel (a)	Sea level rise: observations and projections 2020-2100, 2150, 2300 (relative to 1900)	10.7927/adkr-bn17	Link
II & III	SPM 7 and LR 4.4	Panel (a) (left)	Feasibility of climate responses and adaptation in the near-term	10.7927/hjha-bb25	Link
II & III	SPM 7 and LR 4.4	Panel (a) (right)	Potential of mitigation options in the near-term	10.7927/693w-e850	Link
I & II	SPM 3 and LR 3.2	Panel (a)	Risk of species losses	10.7927/5p9h-7y97	Link
III	LR 4.6		Breakdown of average mitigation investment flows and investment needs until 2030 (USD billion)	10.7927/487h-af89	Link
III	LR 2.2	Panel (a)	Historical cumulative net anthropogenic CO2 emissions per region (1850-2019)	10.7927/w239-hp49	Link
III	LR 2.2	Panel (b)	Net anthropogenic GHG emissions per capita and for total population, per region (2019)	10.7927/1n7z-ga15	Link
III	LR 2.5	Panel (a)	Global GHG emissions of modelled pathways	10.7927/gadr-8q65	Link
III	LR 2.5	Panel (b)	Projected emission outcomes from near-term policy assessments for 2030	10.7927/v4mp-d627	Link
I	SPM 4 LR 3.3	Panel (a) (left)	Global surface temperature change relative to 1850-1900	10.7927/606k-d497	Link
I	SPM 4 LR 3.3	Panel (c) (left)	Global mean sea level rise relative to 1900	10.7927/nqqw-6r39	Link
III	SPM 5	Panel (a)	Net global greenhouse gas (GHG) emissions	10.7927/2mvt-f503	Link
III	SPM 5	Panel (c)	Global methane (CH4) emissions	10.7927/7q5a-dc02	Link
III	SPM 5 and LR 4.1	Panel (e) and Panel (b)	Greenhouse gas emissions by sector at the time of net zero CO2, compared to 2019	10.7927/s4kw-9c34	Link
III	SPM 5	Panel (d)	The associated timing of when GHG and CO2 emissions reach net zero	10.7927/kgra-jt25	Link
III	SPM 7 and LR 4.4	Panel (b)	Potential of demand-side mitigation options by 2050	10.7927/5869-rz42	Link
III	SPM 5	Panel (b)	Net global CO2 emissions	10.7927/ywdg-ya18	Link

WGs	SYR Figure	Panel	Title	DOI	DDC Catalog Link
II & III	LR 2.4	Panel (a)	Market Cost	10.7927/7apv-rv15	Link
II & III	LR 2.4	Panel (b)	Market Adoption	10.7927/hzk3-7k35	Link
I	LR 2.1	Panel (c)	Changes in global surface temperature		
I & III	LR 2.1	Panel (d)	Humans are responsible		
I	LR 2.3	Panel (a)	Synthesis of assessment of observed change in hot extremes, heavy precipitation, and drought		
II	LR 2.3	Panel (c)	Observed impacts and related losses and damages of climate change		
I & II	LR 3.2	Panel (c) (1)	Impact of projected global warming levels on maize yield		
I & II	LR 3.2	Panel (c) (2)	Impact of projected global warming levels on fisheries yield		
II	LR 3.3	Panel (b) (left)	Risks on land-based systems		
II	LR 3.3	Panel (b) (right)	Risks on ocean and coastal ecosystems		
I & III	LR 3.5	Panel (b)	Cumulative CO2 emissions and warming until 2050		
II	LR 3.3	Panel (d) (left)	Heat-related morbidity and mortality		
II	LR 3.3	Panel (d) (right)	Food insecurity		
II & III	LR 4.5		Potential synergies and trade-offs between the portfolio of climate change mitigation and adaptation options		

DKRZ

Regional data subsets in support of developing countries

The provision of regional data subsets for the CMIP6 input datasets stored at DKRZ is ongoing. These subsets support developing and economy-in-transition countries to download the high-volume CMIP6 data. The variables have been selected and the regional subsets created. The internal archival workflow was agreed and a first metadata sample has been inserted. The data archival will start as soon as the dedicated funding becomes available.

Complex Citation pilot using Zenodo

The Complex Citation pilot implementation should enable the traceability of the figure creation and the credit assignment to many input datasets. This effort is carried out jointly by DKRZ and CEDA for figures based on CMIP6 datasets, and is related to the work of the Research Data Alliance (RDA) Complex Citation Working Group (WG). A sandbox example is under discussion in regards to metadata content and standardisation. A few examples of Complex Citation objects have been created in the Zenodo sandbox. Experience from the pilot went into the recommendations of the RDA Complex Citation WG.

CEDA

- Community outreach for the Complex Citation Pilot.
- Implementation of Complex Citations for CMIP6-driven figure datasets for WGI

1. Preparation for AR7

CEDA

- Acting as an advocate for community support for CMIP7 data citation and complex citations;
- Keeping data citation on the agenda for ESGF infrastructure development.

CIESIN

Work with Urban Climate Change Research Network (UCCRN) and AR7 SRCities CLAs (who are members of UCCRN) on the Case Study Atlas (CSA) data and interactive products, e.g., localized city-level geospatial data and maps, high resolution EO/remote sensing data, and downscaled climate simulations data. Participation in outreach activities of UCCRN, which engaged with WGII TSU.

DKRZ

Work related to TG-Data liaison in the WGCM Infrastructure Panel (WIP)

As TG-Data liaison the IPCC data and software requirements are discussed and coordinated with the WIP, relevant CMIP Task Teams, and the CMIP infrastructure ESGF. The Rapid Evaluation Framework (REF), a project aiming at harmonizing different existing Evaluation Frameworks projects, was identified as a partner for the Complex Citation implementation (see below).

RDA Complex Citation WG

The Complex Citation approach will enable IPCC to add a short reference to every figure caption of the reports, which gives access to detailed provenance information on the figures creation and assigns credit to the input data providers. This work is coordinated with CSIC and CEDA. The implications of the IPCC FAIR guideline requirements on the REF framework have been discussed and gaps have been identified.

The IPCC use case has been one of the guiding use cases of the WG (see recommendations: https://doi.org/10.5281/zenodo.14106602). First implementation ideas have also been discussed with Jupyter at AGU 2024.

APPENDIX B – TG-DATA Transition Document[2]

1. Introduction

According to TG-Data Terms of Reference[3] (TOR), membership is tied to the assessment cycle of the IPCC, and is updated at the latest with the author selection process of working groups of the assessment reports (AR). Based on these procedures, it is expected that TG-Data membership is renewed during 2025 with the AR nomination process commencing immediately after the AR7 report outlines are discussed and approved during P-62. The objective of this document is to provide insights and reflections from current TG-Data members on the AR6 experience, and smooth the transition into AR7.

The TG-Data membership update occurs at a time when the Data Distribution Centre (DDC) faces multiple challenges. This document describes the expected responsibilities of the DDC in the AR7 cycle, TG-Data' role in ensuring DDC has adequate resources, and the need for coordination between DDC and Technical Support Units (TSU). Considering that the first Lead Author Meeting (LAM1) for the Special Report on Cities (SRCities) takes place in March 2027, new TG-Data members will have pressing issues to work on very early in their tenure.

The TG-Data Transition document is organised around TG-Data roles and responsibilities as described in TG-Data TOR. For each one of them, we comment on both past achievements and recommendations for potential improvements. At the end of this document, we also provide general insights about current experience during AR6, and operational recommendations for AR7. This document complements the TG-Data AR7 Recommendation document presented at 65th Session of the IPCC Bureau as Appendix 1 to Document BUR-LX/INF.2. More general information on TG-Data can be found in the TG-Data webpage[4].

2. TG-Data purpose

According to TG-Data ToR the purpose of the TG-Data is to:

- 1.1 Provide guidance to the IPCC's Data Distribution Centre (DDC) in order to provide curation, transparency, traceability and stability of data and scenarios related to the reports of the IPCC.
- 1.2 Facilitate, in cooperation with the DDC, the availability and consistent use of climate change related data and scenarios in support of the implementation of the work programme of the IPCC.
- 1.3 Facilitate in cooperation with the DDC the availability and use of climate change related data resulting from the activities of the IPCC in accordance with the mandate of the IPCC.

3. Achievements and recommendations regarding TG-Data roles and responsibilities

The focus of TG-Data activities evolved throughout the AR6 cycle. Work started with the preparation of guidelines for FAIR data within IPCC, and their joint implementation by TSUs and the DDC. This process has demanded an important effort and dedication from the DDCs, TSUs and report authors to prepare, clean and document different types of data (input, intermediate and final). With the publication of the reports, attention shifted to outreach, providing training to the practitioner and research community on the use of IPCC related products (e.g. WGI Interactive Atlas and the IIASA Scenario Explorer). Below we present a recount of achievements and suggest recommendations for each of TG-Data's roles and responsibilities.

[2] This document will be later prepared as a stand alone document to be included at TG Data website
[3] https://www.ipcc.ch/site/assets/uploads/2020/10/TG-Data_TORs.pdf
[4] https://www.ipcc.ch/data/

3.1. Provide oversight of the DDC'sactivities, in close liaison with the three IPCC Working Group Bureaus (WGBs).

Achievements

- TG-Data co-chairs held monthly meetings with DDC managers to coordinate activities, facilitate collaboration with TSUs and plan resources;
- Bureau and Panel reports systematically include sections describing DDC data holdings and catalog statistics;

Recommendations

- Ensure WG Co-Chairs are aware of relevant activities within DDCs, either through TSU representatives or meetings with TG-Data Co-Chairs;
- Updating the DDC MoU as the DDC structure evolves during AR7;

3.2 Identify in close liaison with the Co-Chairs or their representatives of the three Working Groups (WGs) relevant external sources of data, scenario information, and external data partnerships.

Achievements

TG-Data helped materialise different external partnerships during AR6. The following lists actions taken jointly with partner organizations related to data access and best practices in open science.

- Review WGI Interactive Atlas FAIR practices[5];
- Work with WCRP WGCM to license CMIP6 model outputs under CC-BY-4.0;
- Work with IIASA to develop outreach material for its Scenarios Explorer;
- Work with WGI CLAs to organize WGI Atlas outreach activities;
- Advance the concept of “complex citations” in collaboration with the Research Data Alliance (RDA);

Recommendations

- In collaboration with WG Co-Chairs, participate in discussions with data providers to facilitate author access to data and metadata with proper licensing, versioning and crediting information allowing reuse. For example:
    - Liaise with relevant processes/institutions e.g. WRCP CMIP and CORDEX and have an IPCC TG-Data representative in the WGCM Infrastructure Infrastructure Panel (WIP);
    - Establish partnerships with WGIII relevant institutions (e.g. IEA)
    - Establish new partnerships with earth observation data providers (e.g. NASA, ESA and JAXA) to support authors from regions with sparse measurement networks;
    - Establish links with broadscale surface, near surface and oceanic observations networks (e.g. AGAGE, NOAA, CSIRO, ICOS);
    - Consider engagement through the WMO Greenhouse Gases and Related Tracers Measurement Techniques (GGMT) meeting and the G3W project[6];
    - Consider reaching out to the Global Climate Observing System to discuss plans for “climate data centers” and potential synergies with IPCC activities;
- Strengthen collaboration with institutions advancing best practices in Open Science, such as:
    - The Technical Support Unit for Knowledge and Data of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES);

[5] Iturbide, M., Fernández, J., Gutiérrez, J.M. et al. Implementation of FAIR principles in the IPCC: the WGI AR6 Atlas repository. Sci Data 9, 629 (2022). https://doi.org/10.1038/s41597-022-01739-y

[6] https://wmo.int/activities/global-greenhouse-gas-watch-g3w

- National Assessments (e.g. USA, Japan, EEA);
- The Research Data Alliance, whose work on complex citations is highly relevant to IPCC data traceability and credit assignment to external data providers;

3.3 Provide in close liaison with the Co-Chairs or their representatives of three WGs guidance to incorporate consistently and efficiently relevant regional data and scenario information into the IPCC assessment work by developing and proposing policies and structures that will help to link and curate data as needed and used by the Co-Chairs or their representatives of the three WGs.

Achievements

- Development of a key document that guided the process on how to make the IPCC assessment process FAIR (FAIR guidelines[7]);
- Information on the provenance of the figures provided by the authors through the TSU was used by the DDC at DKRZ to document for individual CMIP6 datasets the connections to the final/figure data, the code and the AR6 figure page. This information will be published as ComplexCitation pilot using Zenodo enabling DDC at CEDA to refer to this provenance information[8].

Recommendations

- Given the evolving nature of open science and FAIR principle implementation we recommend a constant review and update of the FAIR Guidelines document and improved integration into IPCC procedures, e.g. such as in reporting potential data error issues through the Error Protocol process;
- We recommend an early engagement with scenarios development community (IAMC, etc) on the guidance on use of new scenarios in the AR7 cycle;
- We recommend an early engagement with the city climate change research community, such as Urban Climate Change Research Network (UCCRN), on collaboration of input data and applications development in the AR7 cycle, especially SRCities;
- We recommend to implement the RDA Complex Citation recommendations[9] into the AR7.

3.4 Recommend partnerships with external organisations to ensure the stability of the IPCC data sets they hold.

Achievements

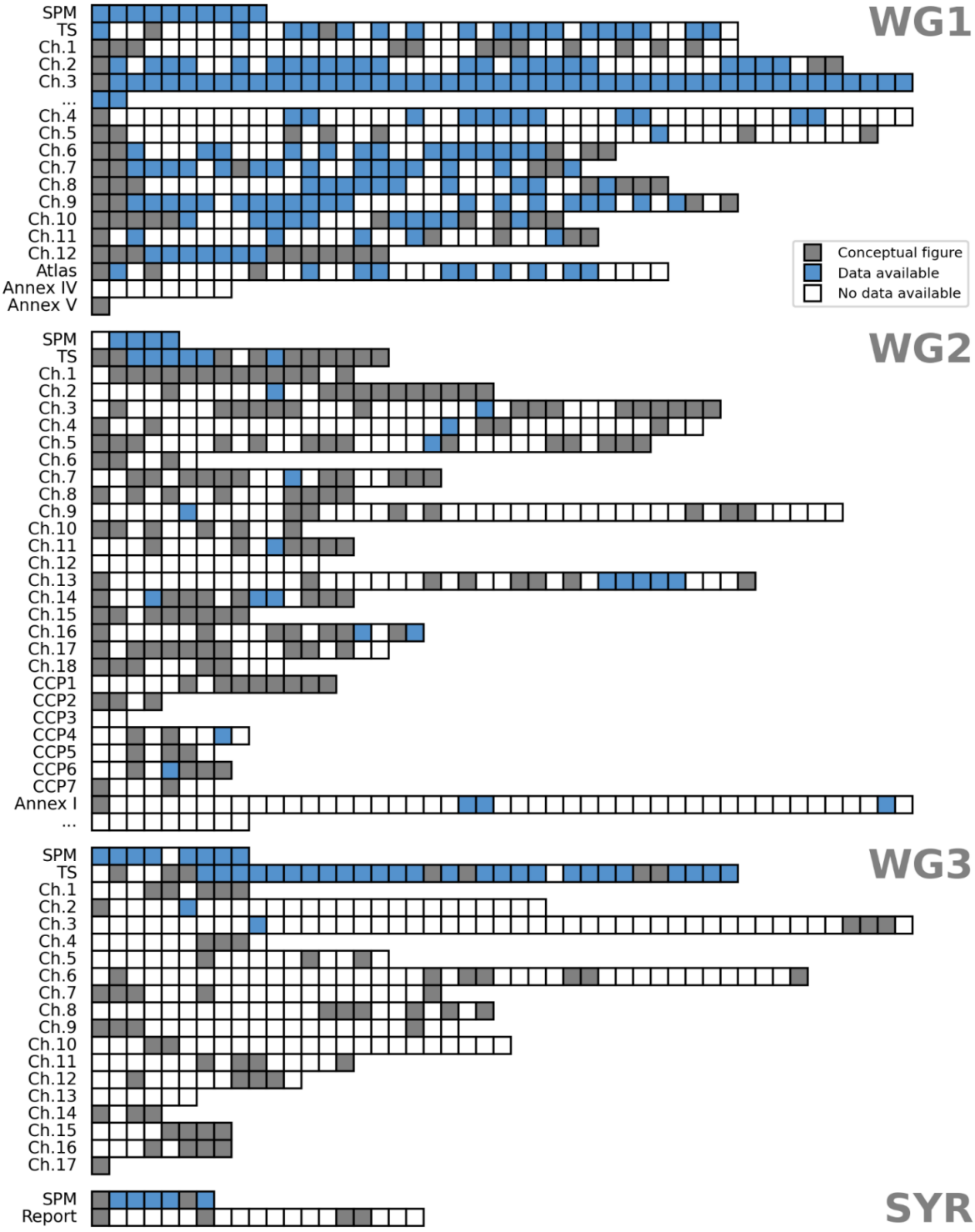
- In case of CMIP6, the IPCC DDC ensured long-term preservation of the subset of CMIP6 used within AR6 WGI, as agreed in the WCRP WIP as white paper[10];
- Long-term preservation of CORDEX data subset included in the WGI Interactive Atlas;
- Implementation of the FAIR principles for a subset of final figures. In Figure B.1 we present the final accomplishment in terms of figures that were included in the process.

Recommendations

- Identify DDC partner to take over responsibilities previously held by DKRZ to curate and archive CMIP climate model outputs and the planned archival of the data underpinning the WGI Interactive Atlas;
- Extend the curation of final figures to a large fraction of figures generated by AR7;

[7] https://zenodo.org/records/6504469
[8] See https://docs.google.com/presentation/d/15AruKRX1FcQvs6yBhgBP-60q1kLHiNDo/edit#slide=id.p6
[9] https://doi.org/10.5281/zenodo.14106602
[10] https://doi.org/10.5281/zenodo.35178

Figure B.1. Data availability per report and chapter. Each square stands for a graphic, and is colored gray if it is conceptual, blue if its underlying data is available at the DDC, and white if it's not linked to a data source.



3.5 Provide expert information on data and scenarios in support of the implementation of the work programme of the IPCC

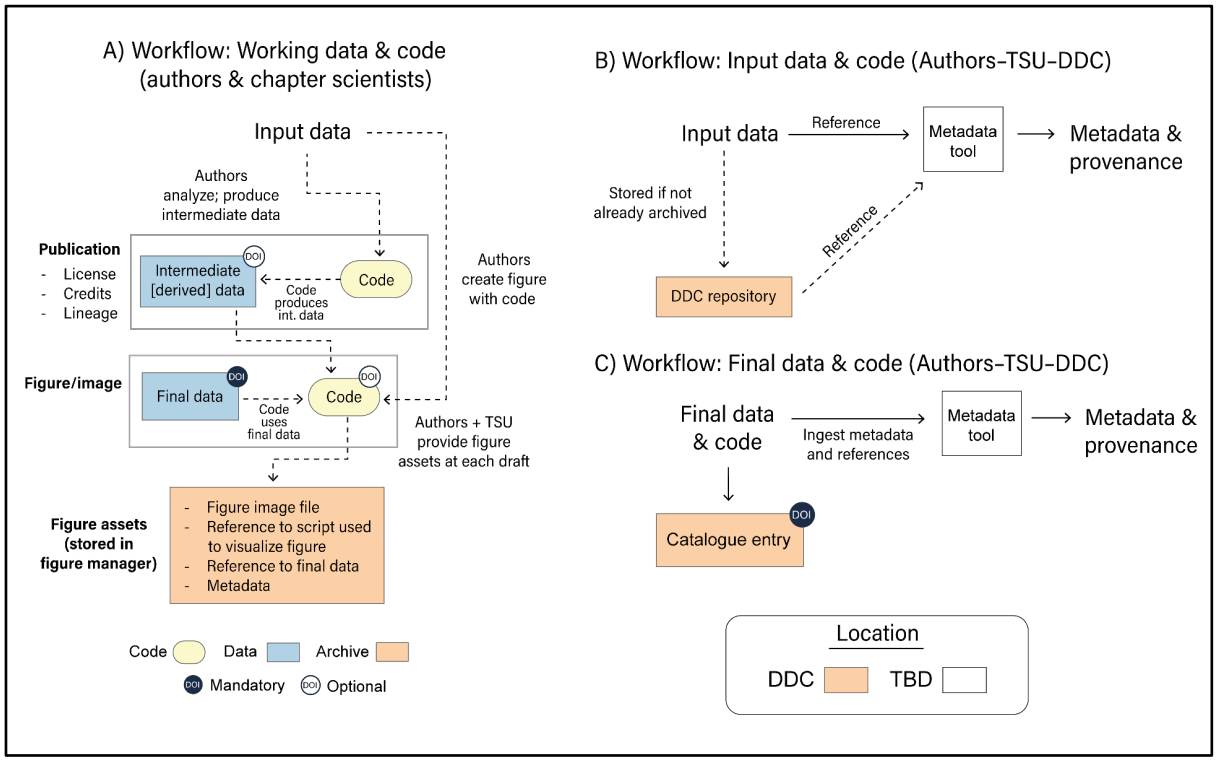
Achievements

- Elaboration of FAIR Guidelines[11] and their implementation (see Appendix B.1);
- Elaboration of Licence guidelines[12];
- Publication of software[13] for the production of many IPCC WGI AR6 final figures;
- Represented data publication practice in the IPCC Informal Group on Publications and Translations (IGPubs)

Recommendations:

- Recommendations for AR7 regarding the life cycle management of reports' figures and associated artifacts (data and software) have been initiated by the TG-Data and the TSUs. These include guidelines for figures produced programmatically through scripts (and managed via a GitHub repository) as well as those generated using standard software, such as Excel or similar tools;
- The Data management workflow draft, documented in Figure B.2, shows the ideal high level process that should be implemented for the final release of the reports. We recommend that all report drafts follow this workflow, allowing for reduced metadata details initially, provided all artifacts are included;
- The workflow may be refined in collaboration with TSU-DDC-TG-Data, also depending on the Figure and Metadata Management tools that will be made available to authors later in the cycle.

Figure B.2. Draft data management workflows for AR7. Panel (a) describes the recommended workflow for working data and code, panel (b) for input data and code, and panel (c) for final data and code.



[11] https://zenodo.org/records/6504469
[12] https://zenodo.org/records/7431834
[13] https://github.com/IPCC-WG1

3.6 In cooperation with the co-chairs or their representatives of the three WGs, develop and update good practice guidance materials related to data and scenarios, targeting IPCC authors who lack familiarity with the IPCC process and/or the relevant data and scenarios.

Achievements

- We developed workshops with authors to explain tools like ESMValTool and the WGI Atlas and also explain the procedures of FAIR implementation[14];
- TG-Data members interacted with authors starting with WGI LAM3 and WGII LAM3, then participated in a virtual session of WGIII LAMs afterwards.

Recommendation:

- Focus outreach and training activities for authors in the form of workshops and webinars, complemented by regularly updated training materials that are made publicly accessible for reference; Special attention should be given to WGII and WGIII
- Start interactions in LAM1 to show to authors the objectives and principles of FAIR implementation in IPCC. At LAM2 TSU could organize an author workshop and between FOD and SOD (during the Expert Review process) more frequent author virtual training sessions could be organized;
- TG-Data has initiated the development of training material on FAIR practices for managing data, software and figures throughout the IPCC reports lifecycle. The tutorial is collaboratively developed using a dedicated GitHub repository[15], compiled, and made accessible online, ensuring authors have easy access to these resources. We recommend sustaining and further refining the material through the new task group, working in close collaboration with the TSUs.

3.7 Contribute to building capacity in the use of data and scenarios for climate-related research, particularly in developing and transition-economy regions and countries. e.g. through encouraging activities such as expert meetings and liaison with relevant academic institutions to address the requirements of developing countries. To achieve this, TG-DATA may work with organisations and activities that have training as their core mandate but would not develop training programmes on their own.

Achievements:

- TG-Data prepared a dedicated web page which included description of TG-Data, membership, activities and links to guidance documents, data and outreach activities of IPCC products: https://www.ipcc.ch/data/
- Elaboration of the DDC data catalogue
- TG-Data prepared two Expert Meeting proposals, one on *Probabilistic Risk Assessments of Climate Hazards* (IPCC-LX/Doc. 11), and another on *Earth Observation data accessibility for climate studies* (IPCC-LXI/INF. 7) the latter is still under consideration.
- TG-Data work was presented at the following conferences and meetings:
    - International Data Week 2023 (IDW23), Salzburg, Austria, 23-26 October 2023 (Session Data Linking / Knowledge Graphs): Stockhause, M., Pirani, A., Sitz, L., Krüss, B., Pascoe, C., MacRae, M., Anderson, E., & Fisher, E. (2023, October 25). Implementation of the IPCC FAIR Guidelines into the Sixth Assessment Report (AR6): benefit, challenges and recommendations for AR7. International Data Week 2023 (IDW23), Salzburg, Austria. Zenodo. https://doi.org/10.5281/zenodo.10039597
    - EGU 2023: Open Science and Data Help Desk: Stockhause, M., Sitz, L., Pascoe, C., Pirani, A., Anderson, E., Cammarano, D., & MacRae, M. (2023). IPCC FAIR data approach. Zenodo. https://doi.org/10.5281/zenodo.7825876

[14] https://www.ipcc.ch/event/wgi-training-on-data-and-software-development/
[15] https://github.com/IPCC-AR7/ipcc-author-guidance

    - EGU 2024: Open Science and Data Help Desk: Stockhause, M., Pascoe, C., Sitz, L., & Pirani, A. (2024). IPCC FAIR data approach. Zenodo. https://doi.org/10.5281/zenodo.10821975
    - AGU 2024, Washington DC, 9-13 December, Oral Sessions and Poster Sessions (Xiaoshi, Martina, David M, Charlotte P., Molly MacRae)
      Using Complex Citations to Close the Provenance Gap Between IPCC AR6 Figures and CMIP6 Simulations, C Pascoe et al. https://doi.org/10.5281/zenodo.14605443
      Implementing FAIR Data Principles in the IPCC AR6 WGI Report, C. Pascoe et al. https://doi.org/10.5281/zenodo.14605539
      Benefit and limitations of the application of the TRUST principles on the jointly managed IPCC Data Distribution Centre, M. Stockhause et al. https://doi.org/10.5281/zenodo.14626702
      Collaborations across boundaries in the Data Distribution Center (DDC) of the Intergovernmental Panel on Climate Change (IPCC) to support climate assessments and interdisciplinary applications, X. Xing et al.
      Building a FAIR Foundation: Managing The IPCC Data Distribution Center (DDC) Catalogue, A. Milward et al.
- TG-Data together with WGI prepared three regional outreach activities linked to the outcomes of the Working Group I report that was released in 2021[16]. The objectives of these activities were to:
    - Present the main results of the WGI report;
    - Engage with the regional research practitioner community over specific regional domains;
    - Present the data availability with special emphasis on the Interactive Atlas (IA) providing regional information and synthesis (from the Technical Summary and the regional chapters 10-11-12-Atlas Chapters).
- TG-Data together with WGIII prepared five regional outreach activities linked to the outcomes of the Working Group III report that was released in 2022[17]. The objectives of these activities were to:
    - Present the main results of the WGIII contribution to the IPCC Sixth Assessment Report;
    - Engage with the regional research practitioner community over specific regional domains;
    - Present the data availability with special emphasis on the AR6 Scenarios Database and Scenario Explorer providing regional information and synthesis.

Recommendations

- In the case interactive products are produced in AR7, we recommend to prepare outreach activities related to these products prior to the final report publication date. This implies early engagement with potential authors willing to participate and also external regional partners willing to host the activities;
- Continue to present TG-Data and DDC work at major relevant data conferences and meetings and those IPCC authors and agencies are involved with, such as International Data Week (IDW), UN World Data Forum (UNDWF), EGU/AGU;
- Expand the nature of outreach and training activities with a focus on researchers in developing countries (aside from authors) in the principles and tools used for FAIR implementation in the form of workshops and webinars;

[16] https://www.ipcc.ch/event/interactive-atlas-regional-webinars/
[17] https://www.ipcc.ch/event/ipcc-tg-data-scenario-database-and-scenario-explorer-webinars/

- In consultation with WGII Co-Chairs contribute from a data perspective on the elaboration of the revision and update of the 1994 IPCC Technical Guidelines on impacts and adaptation.

3.8 Explore in close consultation with the Co-Chairs or their representatives of the three WGs options for a sustainable structure, functioning, and resourcing for the DDC.

DDC has been a key component of the data management process of IPCC since 1997[18]. Up until AR6, DDC were tasked with archiving key input datasets used through AR. With AR6 and the implementation of FAIR guidelines, DDCs were also asked to curate and archive final figure data. This occurred at a time when resources at their disposal to contribute to IPCC were declining or becoming less predictable. As a result, the operation of DDC services in 2024 and 2025 is sustained through direct funding from the IPCC Trust Fund. This is an interim solution, and a short term objective for 2025 is to mobilize resources to go back to a model where countries contribute DDC services to the IPCC.

Achievements:

- Incorporation of new DDC members (CSIC, Metadatawork), formalised through a Memorandum of Understanding[19];
- Attempts to increase funding and external collaboration to DDC were executed by TG-Data Co chairs in coordination with IPCC Secretariat. This included conversations with potential external donors and the publication of resource mobilisation letters. The outcome of this process was the financial contribution received from the government of Australia, France and the Trottier Foundation.
- The IPCC Panel at P60 approved the use of the IPCC Trust Fund to secure DDC services to the IPCC. This process is to be repeated for 2025, but should be replaced by national contributions that do not require Trust Fund support.

Recommendation

- Pursue work with IPCC Secretariat to mobilize resources for DDC;
- Make sure the process is implemented ensuring proper structure, functioning and resourcing for the DDC to:
    - Cooperate with TG-Data in facilitating the availability and consistent use of climate change related data and scenarios in support of the implementation of the work programme of the IPCC.
    - Cooperate with TG-Data in facilitating the availability and use of climate change related data resulting from the activities of the IPCC in accordance with the mandate of the IPCC.
- Make sure the process is implemented following procedures that impede conflict of interests

1. TG-Data mode of operation

Below is a description of how TG-Data operated during the AR6 cycle. This mode of operation should be revised and updated if necessary by the new TG-Data members.

[18] Stockhause, M. and Lautenschlager, M.: Twenty-five years of the IPCC Data Distribution Centre at the DKRZ and the Reference Data Archive for CMIP data, Geosci. Model Dev., 15, 6047–6058, https://doi.org/10.5194/gmd-15-6047-2022, 2022.
[19] https://zenodo.org/records/5914483

TG-Data organised its work around different subgroups that were more or less active at different stages in the cycle:

- **Executive sub-group**:
  - Roles: Coordinate TG-Data activities; Ensure subgroups are progressing toward their own deliverables; Strengthen connection to all WGs and TSUs.
- **Data prioritization sub-group:**
  - Roles: Identify key datasets used by IPCC authors whose long term archival is not guaranteed.
- **DDC subgroup**
  - Roles: Manage the DDC pages of the website; Liaison between TSU and DDC.
- **External Partnerships Subgroup**
  - Roles: Create linkages with organizations sharing TG-Data goals; Identify potential new DDCs (for example in developing countries); Establish connection with organizations sharing similar objectives.
- **FAIR Subgroup**
  - Roles: Develop cross-WG data/code curation guidelines; Develop technical guidelines for FAIR principles; Review of the success of the implementation process; Organize expert meetings; Prepare work for further steps (AR7).
- **Web pages and Outreach subgroup**
  - Roles: Create web page content; Write guidance material; Develop training material; Organize expert meetings and training workshops; Conduct user surveys;

We suggest using the help offered by the Secretariat to ensure subgroups have regular meetings and follow-up on action items. Incoming members are welcome to review the subgroup mission and organisation.

It is expected that TG-Data co-chairs participate at both Panel and Bureau meetings in person or virtually especially if being asked by both groups to present a progress report. Progress reports are sent to the IPCC secretariat at least one month prior to the date of the meeting. Special formats for the preparation of these reports are provided by the Secretariat.

TG-Data members are expected to participate in an annual Face to Face meeting and also in virtual teleconferences that are organised throughout the year (typically one each 3 months).

To provide potential future guidance to new TG-Data members the following list provide contact information to all TG-Data members: List of expertise[20]

Finally, some key documents that need to be considered in TG-Data are the following:

- TOR[21]
- FAIR Guidelines[22]
- License guidance[23]
- AR7 recommendation[24]
- TG-Data paper[25]

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20 https://docs.google.com/spreadsheets/d/1ogjwjli1kSxqFqxeai60VLxf2TRHqe2sgr4Gw3zDyeo/edit?gid=0#gid=0

21 https://www.ipcc.ch/site/assets/uploads/2020/10/TG-Data_TORs.pdf

22 https://zenodo.org/records/6504469

23 https://zenodo.org/records/7431834

24 https://doi.org/10.5281/zenodo.10059281

25 https://doi.org/10.1371/journal.pclm.0000533

Appendix B.1 - Archiving of input and final datasets in AR6 cycle via TSU-DDC collaboration

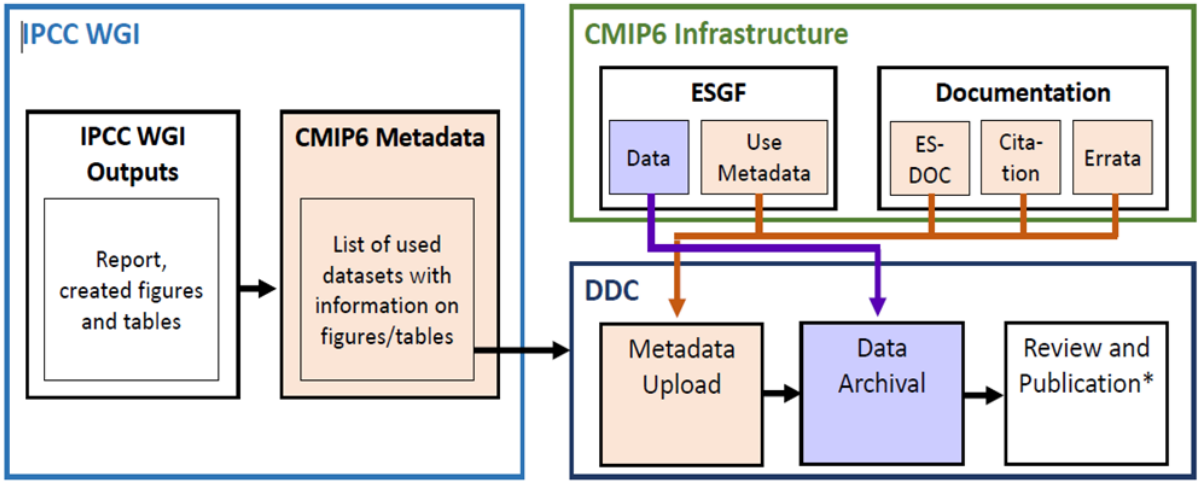
An important aspect of TG-Data work is related to collaboration between the DDC, the TSU and Authors. In preparation for AR7 we provide here some insights about how this collaboration could happen based on the AR6 experience.

Archiving CMIP6 Input Data

The information which datasets of the CMIP6 data was used in the different figures were provided by the TSU of WGI per chapter (Figure B.3). With this information the datasets for archival were identified and the metadata was gathered from CMIP6 infrastructure components such as ESGF index, ES-DOC, CMIP6 Citation Service and Errata Service. The archival and curation process is documented as part of the IPCC WGI GitHub repository (https://github.com/IPCC-WG1/DDC-AR6-CMIP6-Data-Archival; Stockhause, M., Wachsmann, F., & Krüss, B. (2023). DDC AR6 Reference Data Archival of CMIP6 input datasets. Zenodo. https://doi.org/10.5281/zenodo.8109876).

After the data archival the information about figure usage of the data was used to add references to the software, the final datasets and the report/figure webpages using the WGI GitHub information on software/final dataset. These connections between the different digital objects were published as a Complex Citation pilot.

Figure B.3. High-level archival workflow for the CMIP6 Input data subset used in AR6 WGI.



The archiving of WGI figure data

Close collaboration between the WGI TSU and CEDA enabled the publication of 226 figures from IPCC 6th Assessment Report (AR6) WGI.

It is worth noting that, except for the figures from the summary for policymakers, the archival of figure data occurred after the report had been published. This presented its own challenges in terms of interaction with authors, but at least meant that the figure data was less likely to be in a state of flux.

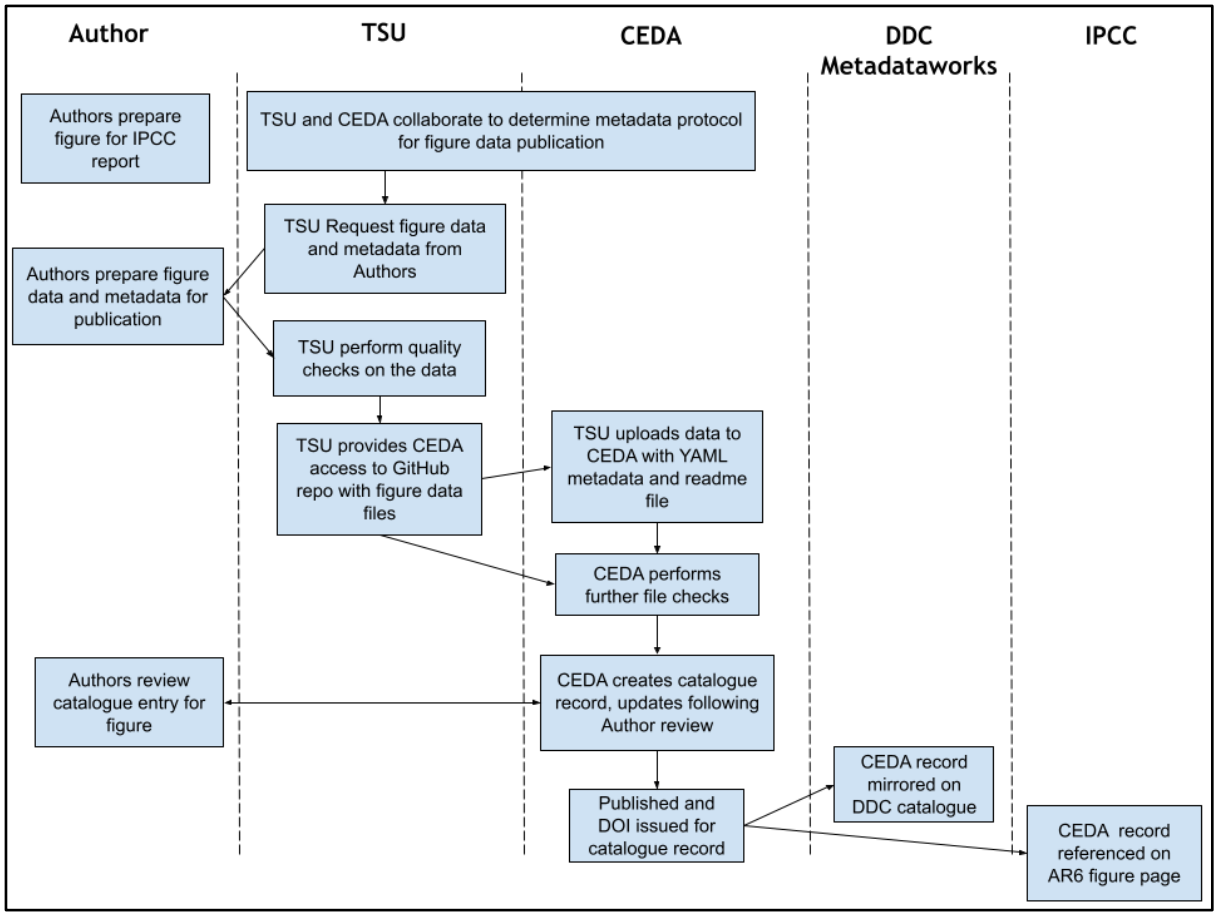
Workflow (refer to Figure B.4):

- TSU liaised with authors to collect information about the figure data and the figure data files.
- CEDA archived* the figure data and create a catalogue record.
- Authors reviewed the figure catalogue record.
- CEDA published the figure data and, where appropriate, issued DOIs.
- The CEDA catalogue record for the figure was mirrored on the DDC.
- The CEDA catalogue DOI was referenced from the figure page in the IPCC AR6.

A catalogue record was created by CEDA for all of the figures included in this process.

Catalogue records contained a version identifier. Updated figure datasets were issued with a new catalogue record.

Figure B.4: Figure publication workflow for WGI figure data publication workflow



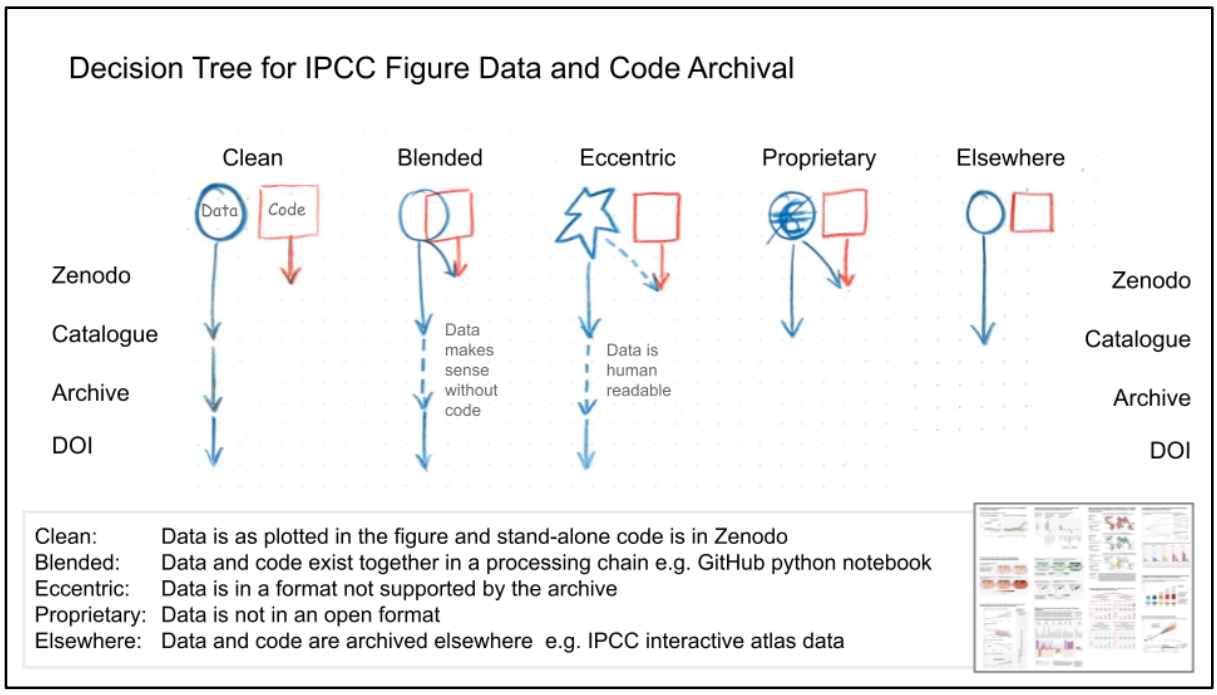
Where data was archived:

In some instances data and code were blended in processing chains a decision tree (Figure B.5) was used to identify the appropriate location for data archival; Zenodo and/or the CEDA archive.

It is expected that guidance and earlier intervention with IPCC authors in AR7 will see more cases with a clearer separation of figure data from the processing chains that created them. Including the provision of templates for the structuring of datasets and metadata.

It is hoped that clear data management instruction for authors will streamline the eventual data publication workflow.

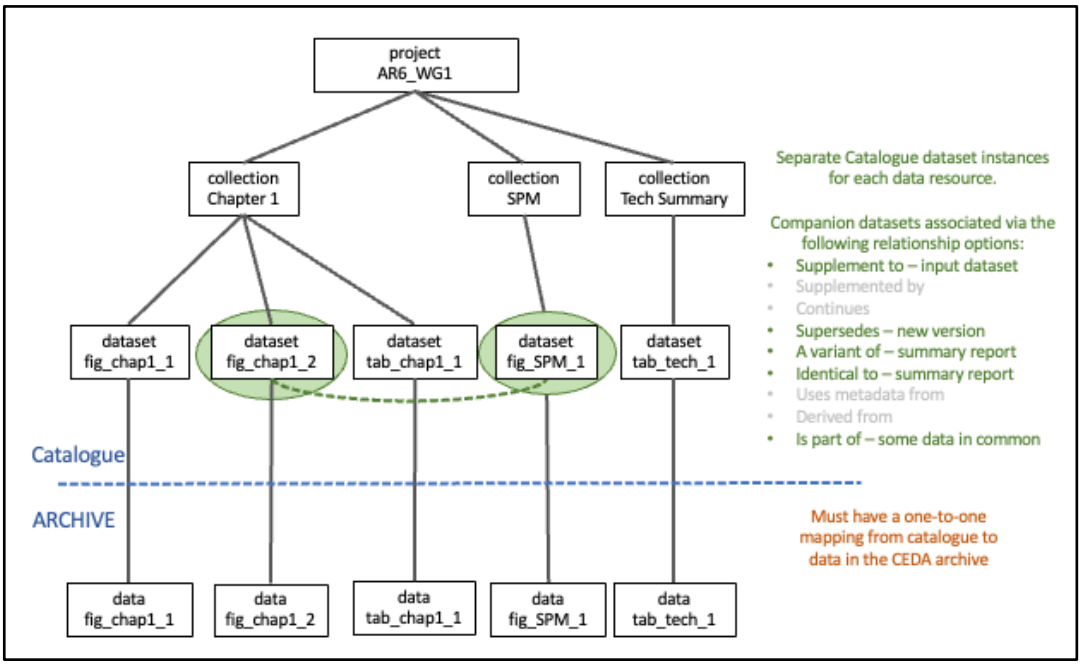
Figure B.5: Decision tree for WGI data archival



Catalogue Architecture:

The nature of the CEDA catalogue database required there to be a one-to-one mapping between a figure catalogue record and the archived dataset (Figure B.6). If a figure's data was used again in, say, the summary for policymakers, a separate instance of the dataset was archived and the two instances were associated with each other via a relationship descriptor.

Figure B.6: Catalogue architecture for WGI figure data publication at CEDA.



Specific choices about the nature of the catalogue structure for archiving the WGI figures were made to fit within the confines of the existing catalogue schema used by CEDA. This is not a mandate, other choices could be made.

The archiving of figure data for the WGII and WGIII
The figure data publication for WGII and WGIII followed a similar methodology.
Data was collected for figures in their summary for policymakers and for some figures in their technical summary.

Workflow/procedure:
WGII and WGIII figures were first created by authors and then handed to a data and graphics officer in the TSU to give them a unified look and feel. This is different to WGI where authors were generally responsible for the publication of their own figures. The WGII and WGIII TSUs worked with authors to retrieve figure data. DDC and TSUs worked together to create metadata forms. The TSU graphics officer provided figure data to the DDC (CIESIN) and/or MetadataWorks and completed a metadata form which included: title, authors, year of publication, abstract, temporal coverage, spatial coverage, data format, data volume, version and data licence (licence was required to be cc.by.4.0).

The DDC (CIESIN), as the data publisher, performed quality control (QA/QC) in which the uploaded data was checked vs the figures in the assessment report.

The content provided via the metadata form was used to generate a landing page for each of the datasets. The landing page was reviewed by the TSU graphics/data officers and in some cases the authors also reviewed. Once the landing page, data and metadata were approved, DDC (CIESIN) issued the DOI and published the data set.

The dataset record was then mirrored on the Metadataworks DDC catalogue.

The archiving of input data for the WGII
Workflow/procedure:
Certain WGII authors contact TG-Data for assistance on archiving the input data used in the chapters. DDC (CIESIN) worked with graphics/data officers to assess the data status to see if the data were archived elsewhere. If not, CIESIN contacted the data sources and worked with them on data licensing of the versions that were used in the chapters. Then CIESIN initially archived the data but without minting DOIs. The data DOIs were created and the data were made publicly available when the chapters were finalised.

The archiving of the WGII integrated databases
Workflow/procedure:
WGII graphics/data officers and DDC (CIESIN) worked together to put together three data collections/databases: IPCC Sixth Assessment Report (AR6) Climate Change Risk Assessment Database (A collection of 13 individual data sets), IPCC Sixth Assessment Report (AR6) Observed and Projected Impact Assessment Database (A collection of 29 individual data sets), and IPCC Sixth Assessment Report (AR6) Adaptation Database.
First two were successfully completed before the TSU were closed and archived at DDC (CIESIN).

AR6 Data Rescue work
After TSUs were closed, requests for access to IPCC datasets nevertheless continued. Where these datasets were not already published, the DDC (CIESIN) was advised by the AR6 TSU officers to retrieve the data from authors. The process has been ongoing. The plan is to complete datasets for all figures in the synthesis report by the end of June, 2025. The challenges include missing or lost data after the closure of the TSUs, missing data licensing agreements, version control issues, and missing quality assurance/quality control (QA/QC) so that some data do not match the published figures. It costs much more time and effort to track, retrieve, archive, and resolve the legal and technical issues. If DDC and TSUs work closely together from the very beginning, similar issues can be avoided in AR7.